THE

ELECTRICAL REVIEW.

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TELEPHONES AND LITIGATION.

THE English patent system comes in at times for considerable criticism. The absence of examination and the liability to obtain a patent which may only entitle the holder to a right to expend considerable sums to no purpose is usually regarded as a feature which is much better managed elsewhere. The critical examination in the United States, and the knowledge that, as a general rule, a patent granted there implies some novelty and some right to protection, is usually advanced as a model which the English department might follow with advantage. And yet they do not seem quite happy in "The States." Examination takes time; "Interferences" involve disputes, discussions, and delays. Sometimes the delays are short, sometimes long. When the disputes are ended the patent "issues." On the 3rd of this month three patents were issued to the assignees of Thomas A. Edison, the applications for these patents having been deposited in the year 1877. Not long ago we recorded the issuance of a patent to Emile Berliner, which had been deposited in the Patent Office for about the same period, and which was supposed to cover the fundamental principles of telephone transmitters. The interest in the Berliner patent would seem to have somewhat subsided, and attention is more particularly directed on the Edison patents. The claims are broad enough to control efficient transmitters, and the patent is issued in the year previous to the expiry of the other fundamental patent which has controlled the telephone industry in the United States. The Bell patent, as most of our readers are aware, was much broader in the United States than in England, and it is the Bell patent which has hitherto sustained the monopoly there, whilst it was the Edison patent which sustained it here. The U.S. Bell patent, we believe, expires in 1893, and it would obviously be a very satisfactory thing for the holders of the Bell patent if they could obtain an extension of their monopoly.

This consideration is now exercising the minds of those interested in the subject in the United States, and, so far as we can judge from the remarks of our electrical contemporaries, there is considerable diversity of opinion on the subject. In the first place, it is not taken for granted that the patents would confer any such monopoly, or that the holders have put forth any claims to it. There seems, in fact, to be considerable doubt whether the patents confer any rights at all. According to one of the United States statutes, every patent granted for an invention previously patented in a foreign country expires with the foreign patent, and as the English patent for practically the same invention expired last year, it is really an open question whether the patents were not brought into existence a year after any rights under them died. Unhappily, however, it seems that there is room for

two interpretations of the statute; there may be room for more than two, for all we know; but two is ample as a basis for litigation, and it seems to be assumed that telephones and litigation are synonymous terms.

THE COST OF ARC LIGHTING IN AMERICA.

The municipal authorities of Cleveland have been considering the question of lighting the town by arc lamps, and the following is a summary of two approximate estimates of the cost of establishing and maintaining a 2,000 arc light plant.

Cost of 2,000 light plant.

	A	B
Station buildings	$15,000	$51,000
Steam plant	65,000	102,200
Dynamos and lamps ...	110,000	172,000
Overhead line	175,000	129,120
	$365,000	$454,320

Cost of maintaining 2,000 arc lamps for a year of 4,000 hours burning.

	A	B
Coal, oil, &c.	$18,000	$18,200
Carbons	16,425	26,280
Repairs	10,000	10,000
Labour and superintendence	50,600	30,700
	$95,025	$85,180

It will be observed that the figures for the several items differ very considerably in the two estimates, although both were made out by experts who have had considerable experience in arc lighting, and in a country in which such matters are supposed to have been reduced to the cut and dried state some time ago. The item which is of most interest is, perhaps, the cost of the line, as it is there that the greatest difference between the conditions of such work in America and England is shown; and in this item there is also a considerable difference in the two estimates. In A the price is for 500 miles of wire, or say £70 per mile of wire erected; and in B it is for 650 miles of wire on a 325 mile pole line, or say £40 per mile of conductor, or £80 per mile of double conductor line. Comparing these figures with the cost that would have to be incurred in England, it will be found that the higher figure of £70 per mile of wire will not do much more than buy a cable such as is required by the Board of Trade, and that when the cost of poles, suspending wires, erecting, &c., is added, the price per mile of double conductor line will come out about £240 instead of £80 or £140. As, however, such a plant is not likely to be required except in towns, where overhead wires could not be used under the present regulations, it would be necessary to lay the conductors underground, and the cost would then amount to about £700 or £800 per mile of double conductor. It is easy to see from this one of the reasons which have enabled America to take a place so far ahead of England in the use of arc lamps for street lighting, as with a capital outlay for mains of something like £100 per lamp to be added to the outlay on other plant, it is difficult to earn the amount required for interest and depreciation.

ELECTRICITY AT THE CHICAGO EXHIBITION.

Some interesting figures concerning the arrangements already made for providing electric light and power at the coming exhibition, are given in the *Electrical Review* of New York, in an account of an interview with Mr. Sims, the Chairman of the Committee of Electricity. The boiler plant is to be contained in a building about 600 feet long by 85 feet wide, and is guaranteed to evaporate 450,000 lbs. of water per hour at 125 lbs. pressure, which, as most of the engines are compound or triple expansion condensing engines, is reckoned to be ample for 20,000 indicated horse-power. The boilers are to be supplied by six different firms, and the total sum to be paid to them for the plant is $80,000, or well under £1 per I.H.P. The engines and dynamos will occupy a space of 800 feet by 110 feet, extending along one side of the Machinery Hall the entire length of the building. The engines will be furnished free of cost, the exhibition company building the foundations and running the machines, which will afterwards be returned to the several firms providing them. The arrangements for dynamo machines are not yet completed, but the following particulars are given concerning the proposals for arc and incandescent lighting and for electric power plants. The probable number of arc lamps is 5,000, about 800 to 1,000 of which will be used for lighting the grounds, and contracts have been made already for 3,500 of these, with the option of increasing the number by 1,300 more, the price in all cases being $20 per lamp. The incandescent lighting contracts are still unsettled, but the number of lamps to be used is 93,000, not including those required in the Machinery Hall and Electricity Building, which spaces are being reserved for exhibitions, pure and simple, of incandescent lighting. Provision is also being made for about 3,000 H.P. of electric power, and contracts have been made for 1,800 H.P. capacity of generators at a rental of $2.50 per H.P., whilst the remainder is to be furnished free of cost, on which terms Mr. Sims says he could easily arrange for twice the capacity if there was a place to put it. It will be seen from the above that whatever may be the fortunes of the various contracting firms, the Exhibition Company is obtaining its power and lighting plant on pretty easy terms, and as it is very unlikely that a higher price will be paid than the $5.95 per lamp, at which the Thomson-Houston-Edison combination offered to take the contract for the incandescent lighting, it would appear that this part of the undertaking will also be contracted for at a cheap rate.

The Use of Condensers.

This subject seems to be occupying the French technical press very largely just at present, MM. Geraldy and Rechniewski both contributing articles on this point to recent publications. The latter adds but little to the subject, but gives us a very complete *resumé* of the great flexibility of an alternating system provided with suitable condensers. M. Geraldy considers the commercial aspect of the question; he seems to think that the great value of high specific inductive capacity has not been sufficiently kept in view, and that everything is sacrificed to perfection of insulation. Unfortunately, substances of high S.I.C. seem to be those which show hysteresis with regard to that quantity in the

greatest degree, and hence heat up to an excessive amount when an alternating stress is applied. The great desideratum would be a body of homogeneous structure and high insulating properties capable of fairly thin sub-division, which should exhibit no electric hysteresis and have a high S.I.C.; this is probably too much to expect, and we must therefore be content at present with getting insulation and absence of heating.

Photometry.

THERE is a good opening for some instrument to measure the illuminating power of various sources of light. M. Seguy has recently developed and brought out an instrument which has this object in view. It consists of a radiometer, suspended by a cocoon thread instead of being on a point: it has a mirror attached, and when radiation falls on the vanes, the amount of angular motion produced can be measured as in galvanometers. The sensibility is said to be about the same as that of Boy's radiometer and to be inferior only to the bolometer. For purely optical (or photometric) purposes, an alum cell is placed before the instrument to absorb the dark radiations. Its deflections are said to be quite proportional to the intensity as shown by conforming to the law of inverse squares. If this be so, and the instrument is not too uncertain in action, there should be some demand for it, especially in laboratories.

Wiring for Alternating Currents.

THE American engineer would appear, from a table just published in the *Electrical World*, to have just found out that the resistance of a wire to alternating currents is not the same as its ohmic resistance. The wiring tables of at least one English firm have for some time had Lord Kelvin's corrections added for various periodicities. The present table is purely empiric, and is made by adding 30 per cent. to the direct current values. The influence of various periodicities is not hinted at.

Two-coil Solenoids.

WE would draw the attention of those engaged on electric drills to a paper in the *Proceedings of the Franklin Institute* by Mr. Aldrich. The action of two-coil solenoids is there considered under several conditions of supply of current. The results should be useful to all engaged on designing machines in which this solenoid action is employed.

El Dorado at last!

A PROJECT has recently been broached which seems to smack of the old South Sea bubble days when our great-great grandfathers used to flock to 'Change Alley and plank down their money for the promotion of such schemes as the making of salt water fresh, the extraction of oil from sun flowers, and iron from coal, to say nothing of the importation of asses from Spain. We use the word *seem*, for it must be admitted that the possibility of extracting the precious metals from sea water is well supported by arguments based on actual experiments by C. A. Münster, of Christiania. Münster is by no means the first to turn his attention to this extraordinary question. Malaguti, Durocher and Sarzeand have each proved the presence of silver in sea water, and Sonstadt has determined that it contains gold. Recent experiments by Münster show that the water in Christiania Fjord contains from 19 to 20 milligrammes of silver and from 5 to 6 milligrammes of gold per ton, worth respectively about 0·03 and 0·19 of a penny. Considering the extremely small amounts of precious metals present in sea water Münster considers that no method of precipitation in tanks can possibly be successful, and instances the failure of H. Munktell, who tried precipitation by chemical means at Bömmelö, on the coast of Norway. He thinks that the precipitation must be effected in the sea itself by an electrolytic method. It is proposed that a channel about 60 metres wide between two small islands, well sheltered from sea and wind, where there is a current of about 4 metres per minute, should be selected for experiment, such rocky islands being common off the Norwegian coast. Across this channel 60 plates of galvanised iron, each 2 metres by 3 metres, should be arranged at an angle of 30° with the stream, and an electric current be sent through the series to precipitate the precious metals. The power required, theoretically, for this purpose is calculated by Münster at only ½-H.P., and he thinks that "to produce a current of such trivial potential difference in practice would only require a motive force which could be cheaply obtained from water power, wind, or even by the thermo-electric principle, utilising the difference of temperature between the sea and air. The large anodes required could be cheaply prepared from wood, impregnated with graphite and tar, and carbonised, high conductive power not being required for such a feeble current." Without further comment all we would say is, "Try it!" On Münster's own showing, the cost of the installation would be trivial; he calculates that over £300,000 worth of gold and silver would be obtained per annum, and that "if only $\frac{1}{100}$th, or even $\frac{1}{1000}$th, of this amount were obtained, it would still pay well." Of course this *El Dorado* will be exploited at once. It is fair to say, however, in conclusion, that the author of this extraordinary idea is a man of known scientific attainments, and since we have not heard that any company is to be promoted we cannot but presume that the proposition is made in good faith.

Defective Compasses.

AN interesting article which recently appeared in the *Newcastle Journal*, formed the subject of an excellent "Note" in *The Globe*. After pointing out the necessity, in the case of iron ships for the very best compasses, it says:—"The sum of £14 is given as an instance of what the owners of a large tramp steamer have considered sufficient to fit her out with compasses, barometers, glasses, binoculars, &c. Such scandalous disregard on the part of owners of the safety of their ship and her crew should clearly be punishable by law, and the sooner the better. There is no excuse nowadays for having useless compasses on board a ship, as the beautiful instruments invented by Sir William Thomson reduce the deviation almost to a minimum, so long as they are properly adjusted from time to time; in fact, the Navy and the leading steamship lines have adopted them practically altogether. We sincerely hope that before long it will be the rule that every ship that goes to sea will be fitted out perfectly efficient in this respect, and that there will be a consequent reduction in the number of strandings around our coasts and elsewhere." Exactly so. And we have no doubt that the most successful way to lessen the loss of life and property which yearly takes place round our coasts is not in the first place, by providing appliances for landing shipwrecked crews, as the *Daily Graphic* would have us believe, but, on the principle that "prevention is better than cure," by seeing that ships are equipped a great deal more efficiently than most of them are at present. Defective compasses and inefficient (or absence of) appliances for sounding, owing to what the *Globe* rightly calls "short-sighted parsimony on the part of the owners" as well as want of legislation on the subject, account for a large proportion of wrecks.

Electric Tramways in the United States.

THE last issue of the *Engineering Magazine* contains an interesting article by Mr. L. E. Serrell, M.E., in which the writer treats, from the standpoint of the investor, of the phenomenal results attained through the introduction of electric traction upon the tramways of the United States.

The total expenditure is estimated at £31,000,000, divided among 450 roads, having a total mileage of over 3,600 miles and employing 5,800 motor cars. While deprecating the financial jobbery that in some cases accompanied the substitution of electric for animal power, the author's criticism upon the general results so far secured, is distinctly favourable, and he prophecies that the electric tramway securities will rise steadily in public favour. From a careful examination of the comparative costs of horse and electric lines, he gives the average operating cost of the former as 80 per cent. of gross receipts, and of the latter, as between 60 and 65 per cent. Mr. Serrell calls attention to the undoubted fact that the introduction of the electric motor has been accompanied by many incidental advantages to the travelling public, among which may be cited the great improvement in the roadbed, the introduction of more handsome and roomy cars, electric lighting and double the speed that was possible with horses. These contributions to the public comfort and convenience are regarded by the author as far overbalancing the aesthetic objections to the trolley wire, which at the outset was but slightly less opposed in America than it now is in this country. In the list of prices *bid* for tramway securities appended to the paper, it is interesting to note that the stock of the six lines wholly operated by electricity, is in every case quoted at a premium of from 75 per cent. to 130 per cent.

Tesla's Lecture in London.

This has now been printed in the New York *Electrical World*, being copied from the *Journal of the Proceedings of the Institution of Electrical Engineers*. It appears to give the highest satisfaction to Americans, who are justly proud of their adopted son. Indeed, the picture of the future of electricity drawn by Mr. Tesla is at once sweepingly novel and alarmingly daring. Whether it is all feasible, and, if so, how soon? are questions that arise unbidden to our lips. One shudders at the thought of 100,000-volt distribution being spoken of as "an easy matter," and transmission through 1,000 miles seems to be certainly unnecessary, although it may be "practicable." 20,000 vibrations per second possibly are "few" in the Tesla school; but it will take some time to familiarise work-a-day electricians with such quantities. Mr. Tesla does not consider high potentials, such as he uses, dangerous. This may be so, and as we have pointed out on several occasions, it is no doubt explainable by the little energy used. But in any practical application large power is a necessary accompaniment, and then we think it somewhat rash to say there will be no danger. Perhaps the human body is not affected by electric currents of very high frequency, and there certainly seem to be grounds for assuming such to be the case, judging from our knowledge of the effects of light, heat and sound waves. Yet the case is "not proven" so far; and subjects for testing the truth of this theory are not so forward in offering their persons for the crucial tests, as one would expect. If things go on as they are doing now, we shall find our knowledge on this point increased by the evidence of an unwilling witness. Mr. Tesla believes that light and heat effects are proportional to the product of the frequency and the square of the potential, and suggests using periods of several millions per second! We do not mind the frequencies so much, but are thankful the "Professor" does not intend using millions of volts, at any rate in this little country.

The Wave Propagation of Magnetism.

In a leading article in the Electrical Review for April 29th we dealt with a recent paper by Prof. John Trowbridge, of Cambridge, Mass., U.S.A., on the subject of wave propagation of magnetism. It will be remembered that the Professor obtained negative results in his search for an indication of a definite rate of propagation. In our leading article reference was made to the investigations of Mr. Fred. T. Trouton in this direction, whose endeavours to discover a wave propagation of magnetism along bars of iron and around rings of this metal were equally unsuccessful. This gentleman has recently contributed an interesting letter to *Nature* on the subject, in which he distinguishes two classes of disturbances. For example, in Prof. Ewing's well-known magnetic model, something which looks very like a definite rate is to be seen in the case of a disturbance not sufficiently large to cause toppling over of the "molecule magnets"; that is to say, to cause the little magnets to pass through their positions of unstable equilibrium. On the other hand, with a larger disturbance the phenomenon visibly partakes of a different character. Here, throughout the medium, there are to be seen at irregular moments what may be considered as cases of precipitations of energy, owing to the occurrence of these positions of unstable equilibrium. These two stages should be carefully distinguished, for an essential in wave propagation as opposed to a rate of precipitation of energy (such as a rate of ignition, &c.) is obviously that the medium should not be permanently altered. In some experiments which Mr. Trouton has carried out very much smaller alternating currents than those used by Prof. Trowbridge were employed. But the occurrence of spurious effects, simulating in a remarkable degree the interference nodes looked for must have effectually obscured the true phenomenon, supposing its existence. Where the magnetising force used is as great as that employed by Prof. Trowbridge no indication is to be found of even these spurious effects, and no indication of a definite rate of propagation is likely to be observed. In Prof. Ewing's model, where the magnets point on the whole the same way, representing a higher state of magnetisation, the rate of propagation of a small disturbance affords a more definite problem. Tried experimentally, Mr. Trouton thinks this latter case might afford more satisfactory results. Considering the conditions under which all experiments hitherto made on the wave propagation of magnetism have been carried out, Mr. Trouton is of opinion that this subject requires further investigation before a just decision can be arrived at in the matter.

The Electric Light on Battlefields.

The ubiquity of electricity is becoming almost proverbial. From the "brightest spot on earth" to the bloodstained battlefield is rather a far cry, but there is no end to the application of electricity. A recent telegram from Gratz by Reuter described some experiments of great interest which have recently been carried out successfully there. The difficulty of searching for the wounded on the night after a great battle has been one which has long occupied the attention of military reformers, and the Army Medical Service, in Austria, has been endeavouring to determine how far the electric light may be utilised for this humane end. The value of powerful search lights with reflectors has been proved in naval affairs, and at Suakim and elsewhere our soldiers have found them very effective on open ground. They would be equally effective, under similar conditions, for assisting in picking up the wounded, but when the battle has raged over a wide extent of country, or when the fighting has occurred amidst woods and brushwood, the use of this class of light is attended with difficulty. The need for a special form of light for this purpose having been recognised, the Austrian Medical Service have been experimenting with portable electric lanterns fed by secondary batteries contained in the knapsacks of the men who carry them. These experiments have been carried out under conditions as nearly as possible similar to those which would occur in actual warfare, and the results were so encouraging that it is highly probable that the portable "search-light" will be taken up in earnest by the military authorities in other countries.

SOME DIFFICULTIES IN THE THEORIES OF VAN'T HOFF AND ARRHENIUS.

THE much-debated theories of Van't Hoff and Arrhenius came in for a considerable share of notice from Prof. A. Crum Brown, F.R.S., the other day in his presidential address, at the annual general meeting of the Fellows of the Chemical Society. These theories were not approached in a polemical spirit, but rather suggestively. Whether they are ultimately accepted or rejected by scientists, it must be admitted that they have been productive of important results, and that they have set us thinking about matters which must be looked at from all sides.

Before a theory can be profitably criticised, it must be understood, and many of our readers will have found some difficulty in understanding the theories of osmotic pressure, and the dissociation of ions. The preachers of the new doctrines are not to be blamed for this, although they might, perhaps, have been more explanatory, nor have those who have felt these difficulties any reason to confess exceptional dulness. The doctrines *are* novel and strange, and no mode of presenting them could have made them easy. We have felt this again and again, in presenting our readers with the results of the labours of those who have accepted, or who reject, them.

But it is certainly worth while to endeavour to understand theories which bid fair to revolutionise our way of regarding the workings of matter, and to enlighten us concerning some of the obscure problems of chemical affinity and electricity. The proper questions to be asked concerning any new theories are: Is the theory applicable? Is it likely to be productive? Does it lead to clearer notions as to the relation of phenomena to one another; and so to wider, more generally applicable, more useful theories? Answers to these questions will soon accumulate—answers either affirmative or negative, which will make the discussion of the truth of a theory a needless one.

Prof. Brown very aptly placed the *crux* in each theory before his readers. If we can master their chief difficulties, our prejudices against them will become minimised, and we shall be better able to learn from them.

In the case of osmotic pressure we have a membrane with water on one side and a solution of something on the other. Although the hydrostatic pressure is the same on the two sides water goes through from the water side to the solution side. We should naturally suppose that this implies the existence of a pressure which drives the water through, and can be measured by the hydrostatic pressure which has to be applied from the solution side, so as to balance it and prevent water going through. But the "osmotic pressure" of the theory is from the solution against the membrane, contrary to the direction in which the water flows.

To reconcile this paradox we must consider the nature of the osmotic pressure of the theory. The thinnest, the most delicate septum interposed between the solution and the water is unaffected by the osmotic pressure, if it is impermeable to water. Indeed a membrane permeable to the solvent and impermeable to the thing dissolved is necessary, not only for making observations on "osmotic pressure," but even for forming a conception of it, and, therefore, whenever we come to a difficulty we shall only get into more confusion if we try to reason out the case by means of ideas connected with ordinary pressure. We must go back to the real, the practical definition of osmotic pressure as the difference between the hydrostatic pressure on the two sides of the membrane permeable to the solvent, impermeable to the thing dissolved, when there is equilibrium.

The chief difficulty which is connected with the doctrine of the dissociation of ions may be put in this way: Let us imagine a mixture of hydrogen and chlorine, in the proportion in which they unite, placed in a closed vessel, kept in the dark at the ordinary pressure and at such a temperature that no combination occurs. Here we have the hydrogen and the chlorine particles (molecules) moving freely about among each other, each at its own proper speed, colliding and rebounding, but under the pressure and at the temperature we are supposing, practically uninfluenced otherwise by each other's presence. (If an opportunity were given for diffusion into an indifferent gas, the hydrogen would to a large extent diffuse away, leaving in the vessel a mixture containing a large excess of chlorine.) Let us now suppose an electric spark passed through the vessel: combination occurs, much heat is given out, we find that the hydrogen and chlorine no longer move independently; diffusion does not separate them. Dissolve the hydrochloric acid gas in water and so make a dilute solution. More heat is given out, and yet the theory of dissociation into ions asserts that in this dilute solution the hydrogen and chlorine particles are moving about among each other as independently as in the gas; nay, that there is in the dilute solution an additional kind of freedom, as the particles are single atoms and not pairs, as in the mixture of hydrogen and chlorine gases; and, according to the theory, these hydrogen atoms are moving at a speed proper to them, and the chlorine atoms at a speed, much less, proper to them, but they do not now diffuse away from one another, if the solution be placed in contact with pure water. What diffuses is hydrochloric acid, or, according to the theory, hydrogen and chlorine atoms in equal numbers. We have, then, decomposition of hydrochloric acid without absorption of heat, and independent movements of hydrogen and chlorine atoms at different speeds without the possibility of separation by diffusion.

This apparent paradox has stumbled many. The solution of it turns on the electric charges of the ions, and this has been well explained by Ostwald and other advocates of the theory. Prof. Brown, however, placed the difficulty in the form of a parable, and those of our readers who have not kept up with the "dissociation" researches may find it useful to look at this parable, which, though it is not a strict analogy, may help the imagination where it needs help.

Let us suppose a nomad tribe, consisting of 1,000 or 1,000,000, or any large number you please of men, all exactly alike, and each the owner of a cow. The cows, which are all exactly alike, are all private property, but the land is common, and each man, accompanied always by his cow, moves about from place to place within the territory of the tribe. The men meet one another every now and then, but only exchange a word or two and move off, each with his own cow. Now we shall suppose a change of climate, or an accession of territory, or other change of circumstances, such that it is found more convenient that, instead of each man owning a single cow—his very own—a number of men club together so that each man of the n members of the club has one share in the property of the club; that is, $\frac{1}{n}$ th share of n cows. He gets a share certificate, and the cows are marked as club property. A member of the club need no longer accompany his cow anywhere—he has no particular cow—he can go about independently *wherever there are club cows*, attending to such as he comes across. But his interest in the club property (now his property) prevents his wandering away where there are no club cows, and, similarly, club cows may go about freely *wherever there are club members*, but are not allowed to wander away to places where there are none. No one looking at this new state of society would say, "These men have given up their cows for nothing." They have not given them up. They still possess them, and if you want them you will have to pay for them, just as you would have had to pay the individual owners.

Co-existent with such a club there might be private ownership; indeed, the proportion of club-members to private owners would depend on the extent to which the changes favourable to club life had gone. We may further suppose that the men are not all alike, and that some joined the club with two cows each. Some with horses—each member's share-certificate corresponding to the property brought in. If circumstances change, so that club life becomes rather less advantageous, some members will be paid off, giving up their share-certificates and getting each a cow, or a horse, or two cows (from which, of course, the club mark is removed), according to the number of his share-certificates, the club always retaining those members and that kind of property most suitable to the club.

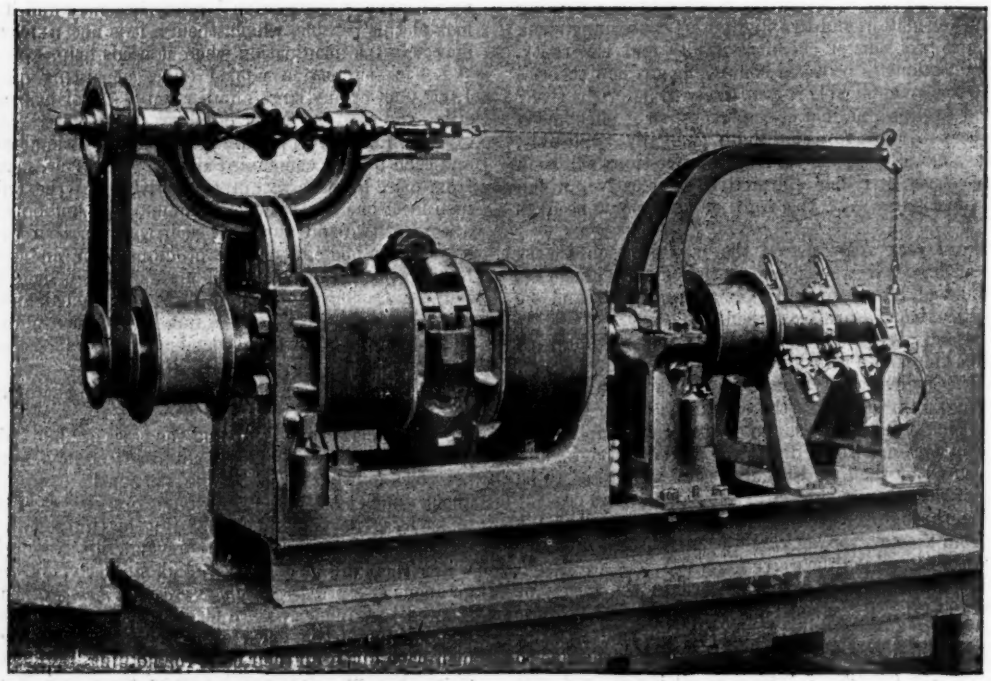
The matter might be pursued further, and we might speak of a tinman who, having originally two shares, steals a share from each of two iron men, who have three each, and goes about with four shares, and is sometimes paid off at that rate, while his victims have to do with two each; but the parable need not be pursued any further. Sufficient will have been said to help in the proper understanding of the

difficulties experinced in connection with the dissociation theory. With all these new theories a proper use of the "scientific imagination" is desirable; they are necessarily incomplete, but are not to be rejected for that. Nothing is to be lost by according them a fair hearing, and this is especially important in regard to those explorations in the regions bordering the domains of physics and chemistry, which are now coming under the control of the great empire of mathematics.

RAILWAY TRAIN LIGHTING PLANT.

The Brush Electrical Engineering Corporation has designed a special plant for train lighting. The plant consists of dynamo, cells, and controlling gear, the carriages being usually wired with all lamps parallel. The lights can be run from cells, whether the dynamo and train are running or not.

The dynamo used is specially adapted for railway work by certain special qualities. For this particular work the special quality required is constant electromotive force over *great range of speed.*



For a three-fold variation of speed (from about 500 to 1,500 revs.), the E.M.F. only varies 2 per cent.

The plant is entirely automatic, only requiring the guard to turn the lights off and on when desired.

When the train is at rest, the brushes of the dynamo are not on the commutator, and the lamps are supplied with current from the accumulator.

The dynamo is driven from the axle of the guard's van by means of a belt. When the train starts (in either direction) the brushes are automatically brought into the correct position on the commutator, and connections are made which give the field the polarity to suit the particular direction of rotation.

When the train attains such a speed as to drive the dynamo at about 500 revs. per minute, which is the speed giving the necessary E.M.F., a centrifugal governor connects a relay with the cells; this relay allows the cells to excite the field, and when the latter are fully excited the charging circuit is closed by an automatic switch, and charging begins. At the same time a small resistance is inserted in the lamp circuit to compensate for the difference of E.M.F. across the mains, due to the cells being charged.

From this initial charging speed the dynamo maintains a practically constant pressure up to the highest speed attained by the train, the usual range being 1 to 3. That is to say, the dynamo starts charging when the train is running at quarter speed, and continues to charge at all speeds above that. That a remarkable constancy of E.M.F. is maintained through a long range of speed variation, will best be seen by the following results of an actual test:

Revolutions.	Volts.	Ampères in lamps.	Ampères, total.
1,420	57	50	65
1,000	57	50	62
875	57	50	59
620	56	49	56

520 dynamo automatically cut out.

The lamp current and voltage was practically constant, the variation of the total current being due to change in the back E.M.F. of the cells.

The absence of sparking in this machine is very remarkable, being attained by means of a centrifugal governor, which rocks the brush-holders in the proper direction against a spring. This governor also answers the purposes of switching the dynamo in or out, and of closing or opening the exciting circuit at the proper speed.

The automatic devices, which are of a very simple and substantial character, are on a principle mainly worked out and patented by Mr. Houghton, telegraph engineer of the London, Brighton and South Coast Railway, who has for many years been closely associated with the electric lighting of the trains on his company's lines.

Successful runs of the plant were made on Friday afternoon before a party of electrical engineers. The dynamo was connected to a main shaft, which, for the time being, acted as the train. At a speed varying from 2 miles to 50 miles an hour, there was no perceptible difference in the lamps, and there was not the slightest hitch in the automatic or regulating arrangements.

We illustrate the dynamo used on the occasion of the trial run. We believe it has been made for use in the Australian colonies.

Telegraphs in South America.—We understand from the *Financial News* that the agent of the Central South American Telegraph Company has applied to the Government for authority to suppress the telegraphic service between San Juan and Mendoza, as that section is quite useless. The company wish to use the materials of that section to improve the main line of telegraph between Buenos Ayres and the Andes.

ELECTRICAL DISTRIBUTION BY ALTERNATING CURRENTS AND TRANSFORMERS.

BY RANKIN KENNEDY.

(*Continued from page* 632.)

THE self-starting synchronous motor described in last article, although highly efficient and self-regulating, has still the drawbacks due to its not starting with any load on.

These motors are used, in the new system of distribution

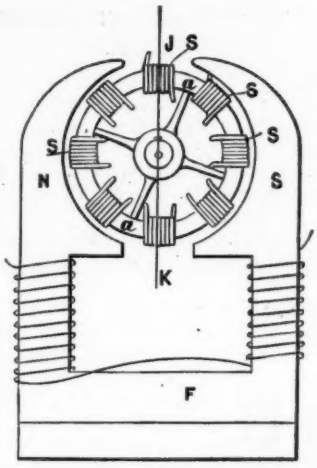


FIG. 8.

by two currents in quadrature phase, to drive the commutators employed at the sub-stations to rectify the two currents into one continuous current. Before entering on the description of the sub-station arrangements, we can consider the two-phase motors, working without commutators, which are applicable for use in a system of distribution by two currents in quadrature phase.

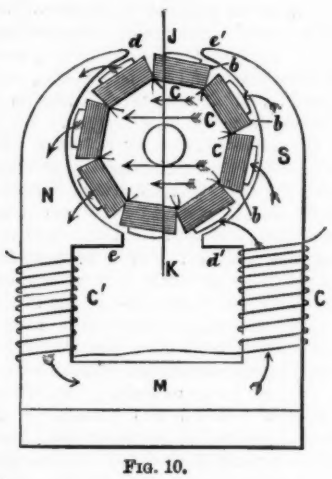


FIG. 10.

The Tesla motor, and other motors acting upon the rotary polar principle, are now well known; they may be employed in any system supplying two-phase currents. But a better principle than the rotary polar principle has been found by the author for working commutatorless motors with two or three-phase currents.

In motors on the rotary polar principle, the multiphase currents acting on an inducing magnet, produces a shifting of poles in a rotary motion, the rotating poles produce induced currents in an armature winding closed on itself, the resultant fields of the inducing rotary poles and the induced armature poles are at a small angle with each other, and the armature poles are dragged round by the rotating inducing poles.

The author has found by many experiments that there are very serious interactions in the working of rotary polar motors with multiphase currents. So much loss was found due to these interactions, that it was determined to work motors with the two or three-phase currents on such a principle that the one current could not directly act or react on the other. One of the principles adopted, consists in providing on the motors a separate inducing magnet or magnetic system for each of the currents, with a separate induced circuit for each magnet or magnetic system. Motors made on this principle have no rotary poles, the poles are oscillatory.

Another principle, found to be highly successful, consists in reversing a quadrature generator, such as that shown in fig. 2, page 568; but reversed alternators require commutators or sliding contacts, so that they have that drawback which does not exist in purely two-phase or multiphase motors.

Another principle upon which two-phase or multiphase motors are successfully worked by the author without any commutators and with the highest efficiency, is based upon the inductor form of alternating dynamo generator. When this form of dynamo is reversed, if constructed for multiphase currents, it gives at once the most efficient and perfect multiphase motor for use in places where no commutator is admissible. This is the form of commutatorless two-phase motor, brought out by the author for use as auxiliary powers

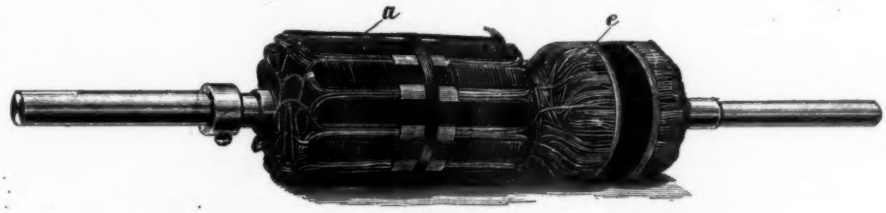


FIG. 9.

on shipboard, and for use in mines. From what has now been said, it will be obvious that there are more methods for constructing and working multiphase motors than that known as the rotary polar method.

Multiphase motors have been constructed with condensers in their design; but condensers, when used in motors for alternating currents, are very dangerous things, and therefore can never be used for motors for ordinary use. The condenser is introduced principally with a view to enable multiphase motors to be run on the existing single alternating current supply systems; but such devices only increase the difficulties and show more clearly how necessary it has become to abandon the primitive simple alternating current systems altogether, and at once introduce a multiphase system.

The motors worth discussing are, 1st, the rotary polar motor, so much written about as used at the Frankfort Exhibition, and so much heard of as the Tesla motor in America; 2nd, the multiphase motors with oscillatory poles; 3rd, the reversed quadrature generator motors; 4th, the reversed inductor quadrature generator motor.

The first two have one great drawback, in that they take enormously large exciting currents. For instance, the figures published regarding the 2 H.P. Dobrowolsky multiphase motors, show that at no load this motor at a frequency of 35, took 30 amperes at 70 volts, an apparent power of 2,100 watts. As there are two circuits taking this apparent power in this machine, the total apparent power at no load was 4,200 watts. At full load each circuit took 100 amperes and 70 volts, or, altogether, 14,000 apparent watts.

Actually, the active current at full load is only about 25

ampères; nevertheless, the transformer to supply this two horse motor would require to be large enough to carry the 100 ampères, and two would be required, one for each circuit, so that for a two horse motor, acting on the rotary polar or oscillatory polar principles, there would be required two transformers, equal each in size to a 10 H.P. transformer.

This enormous size of transformer required by motors excited by alternating currents is their great drawback, a condenser connected in shunt across the terminals of the primary of the transformers would supply the exciting current and relieve the mains and dynamo, but still the large transformers are necessary. The third and fourth class of multiphase motors have continuous current excitement, and therefore have none of the drawbacks due to the enormously large exciting currents required for the first and second class of motors.

For the transmission of power from waterfalls and other sources, the rotary polar and oscillatory polar commutatorless motors must always present these difficulties, due to the alternating exciting currents. The author's method consisting in using a reversed quadrature generator self-exciting by a continuous current gets over these difficulties easily. Introducing a commutator to deal with the small exciting currents in the field coils does not present any serious difficulty. For commutatorless motors suitable for working in mines and in steamships, there is the inductor form of motor which is an inductor dynamo for generating currents in quadrature; this machine reversed and excited in its field coils by a continuous current works as a commutatorless motor, and does not introduce any difficulties in the way of large exciting currents.

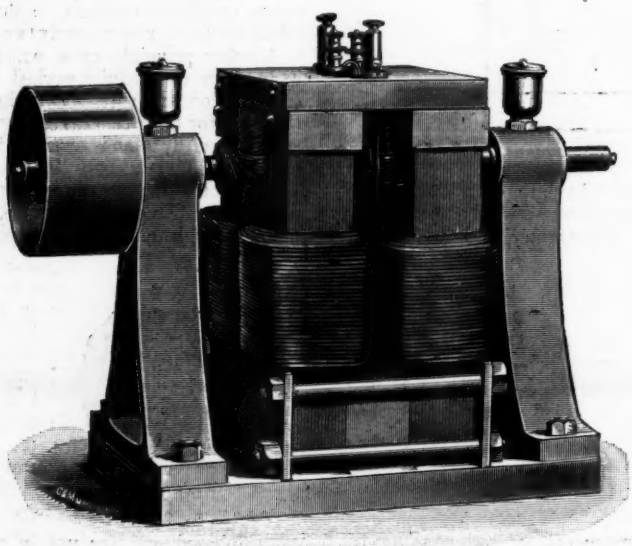


FIG. 11.

A two-phase motor in which there are no rotary poles and no commutators, is shown in fig. 11. Fig. 9 is the armature and transformer on the shaft. Fig. 10 is an end diagram of the transformer part, and fig. 8 is an end diagram of the motor part.

This motor consists of two parts, one part being a laminated pole armature, *a*, fig. 9, carrying projecting teeth upon which are wound coils of wire. This armature is embraced in a field magnet as shown in fig. 10, and this field magnet is excited by one of the quadrature currents, and thereby secondary currents are generated in the coils on the projecting teeth of the armature; in fact, this armature forms the secondary and the field magnet the primary of a transformer, as this part of the motor is called, the secondary currents pass into the coils of a drum armature, *e*, in fig. 9, and cause this drum armature to revolve with power when the field magnet, F, in fig. 8, is excited from the other quadrature current.

Each one of the coils on the drum armature is coupled directly across to two diametrically opposite coils on the toothed secondary, forming a closed circuit.

This motor, like all motors excited by alternating currents, takes very large exciting current. Its simplicity, its great starting torque, and having no commutators, are such great advantages that, even despite the large exciting current required, it can be applied with great advantage in many places.

It must be mentioned that the large exciting currents do not entail large losses in efficiency. The efficiency of these motors is over 80 per cent. in larger sizes, and may be taken as at 75 per cent. for small sizes.

(To be continued.)

FIGURES FOR ELECTRIC LIGHT PRODUCTION.

BY W. H. BOOTH.

(Continued from page 503.)

IN examining the boiler of a locomotive, and comparing it with a stationary boiler of locomotive type, the chief difference, as already stated, will usually be that the former has a much larger number of tubes, the necessity for which arises from the higher rate of combustion of the locomotive by reason of its more powerful draft. The whole question of tube surface in boilers is wrapped in uncertainty. English practice has been and still is to use tubes of brass, whilst Americans use tubes of iron and steel of less heat-conducting power, but which they claim are as efficient as tubes of brass. Some engineers, again, are of opinion that the crowding of an immense number of tubes into a boiler barrel is wrong. They would put in fewer tubes and of larger size, believing that the bulk of the duty of a locomotive boiler is done in the firebox or first few inches of tube length. They state that the tubes are merely surrounded by so much froth and cannot therefore be very effective, whilst the upholders of many tubes say in reply that such froth, which is caused by ebullition, must, if present, be caused by the very tubes which are condemned as useless, and that therefore such condemnation is inconsistent and illogical. On a general review of the matter there appears to be good ground for asserting that the tube area should bear some ratio to the rate of coal combustion, and so we find that for stationary work there are as a rule fewer and larger tubes than in a locomotive, the ratio of grate to total heating surface being as low as 1 : 30 in many cases, and as high as 1 : 70 in locomotives, wherein the coal is burned at rates of 100 and 120 pounds per foot of grate surface per hour. It would therefore appear reasonable to conclude that for stationary work, where the rate of combustion is to be quickened by a forced draught, the number of tubes should also be increased in order to provide a sufficient heat absorbing surface, while it is perhaps as well to so arrange the tubes that they shall be in vertical lines with a

clear space between the vertical rows, rather than to follow the plan of placing them so that there is no clear vertical space. Thus fig. 1 is preferable to fig. 2. The increase in tube area must not, however, be carried to an extreme. It

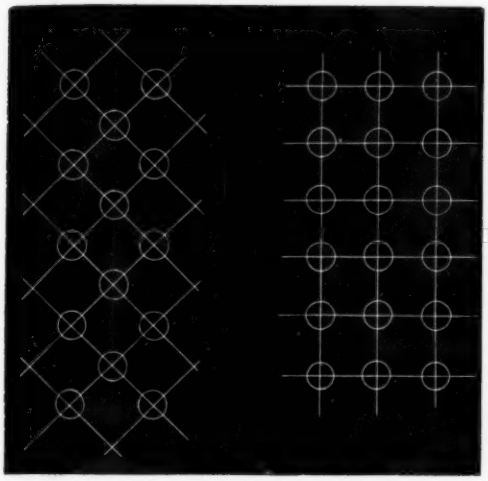


FIG. 1. FIG. 2.

has long been recognised in the best stationary practice that the heating of the working fluid of a steam engine should take place by stages, just as the utilisation of the fluid is carried out in the compound engine.

With the high pressures which are now so much in vogue, the temperature of the steam is high, and may exceed, or closely approach the final temperature of the furnace gases from some stationary feed heaters. It is manifestly impossible that the furnace gases can ever be cooled to anywhere near so low as the steam temperature, and thus it is that beyond a certain ratio there is practically no advantage in adding to the heat absorbing surface of the boiler itself; it having been laid down by one authority that for locomotives, within the proportions possible in practice, the efficiency of heating surface varied only with the fourth root of this surface.

If, however, in place of adding to the heating surface of the boiler an extra capacity in free water communication with it, such as we might do by lengthening all the tubes and the barrel 3 feet, we add instead a separate vessel, similar, let us say, to a 3 feet length of barrel filled with tubes, we can get results very different if we so arrange this addition that all the water fed to the boiler first goes through this separate section, in place of going direct into the hot boiler. It must be understood that putting water at 60° temperature into a boiler at 360° is as foolish as the pre-watt practice of condensing in the working cylinder of the steam engine. By having our boiler cut into two pieces and maintaining the first one at a temperature lower than the boiler, we enable it to absorb heat from the furnace gases which could not be absorbed by the hotter boiler, and by the utilisation, or an approximate utilisation, of the principle of counter currents, we may so arrange matters, that the water entering the boiler proper is nearly at boiler temperature, while the gases finally escaping to the chimney have been exposed to the cooling influence of tube surface containing water at or near 60°, its original natural temperature.

The economy thus to be effected is almost too obvious to require comment, although there are still those who will argue that five boilers and no feed heater must be as good as four boilers and a feed heater of a surface equal to one boiler, just as there are still those who will argue against the much ridiculed, but still correct, heat trap theory of the compound engine. For an electric station where there will be more than one boiler, a feed heater ought to be employed to utilise the waste heat of the furnace, and this is perfectly easy of accomplishment where condensing of the engine steam can be made to produce power and render unnecessary the employment of a feed heater to absorb heat from the engine exhaust. Where this latter is employed the feed must of necessity go forward to the furnace feed heater at, or approaching, 212°, and it may not be possible to reduce the chimney temperature quite so low as where there is no exhaust coil.

Though the principle of stage heating has been applied to the steam engine for a longer time than the utilisation of the working fluid has been effected on the same compound principle, nevertheless for feed-heating, excepting for the taking of the boiler feed from the hot well of condensing engines, the principle has received no extension to compare with the triple and even quadruple working which now characterises the other or cooling portion of the cycle. The reason for this is, of course, that the effect of the counter currents principle is very largely obtained in feed heaters of the vertical water tube type, though it may now be questioned whether an actual division of the feed heater into two sections might not also prove worth its cost. Without, however, carrying the principle too far for simplicity, as the further sub-division might perhaps be deemed, we may almost lay it down for law that the boiler surface cannot be economically extended to a degree sufficient to cool the gases as low as they should be cooled; and that therefore a separate heater is necessary to economy, and the grate surface of the boiler may be from one-thirtieth of the heating surface, for natural draft, to one-fiftieth for forced draft. As regards fire box dimensions there is no such limit of breadth such as is enforced in the locomotive, by reason of the impossibility of exceeding a certain breadth between the frames, and any reasonable breadth may be chosen. A wide furnace, as a rule, can be more easily worked without smoke in the case of ordinary cylindrical underfired boilers than can narrow fires, and it is therefore well to make this dimension large, while at the same time, for the reasons given under the head of fire thickness, it is also good practice to make the box deep, for by doing so there is depth for a thick fire and sufficient room in which to insert an upsloping brick arch below the lowest tubes, without which it is almost useless to expect this class of boiler to be smokeless.

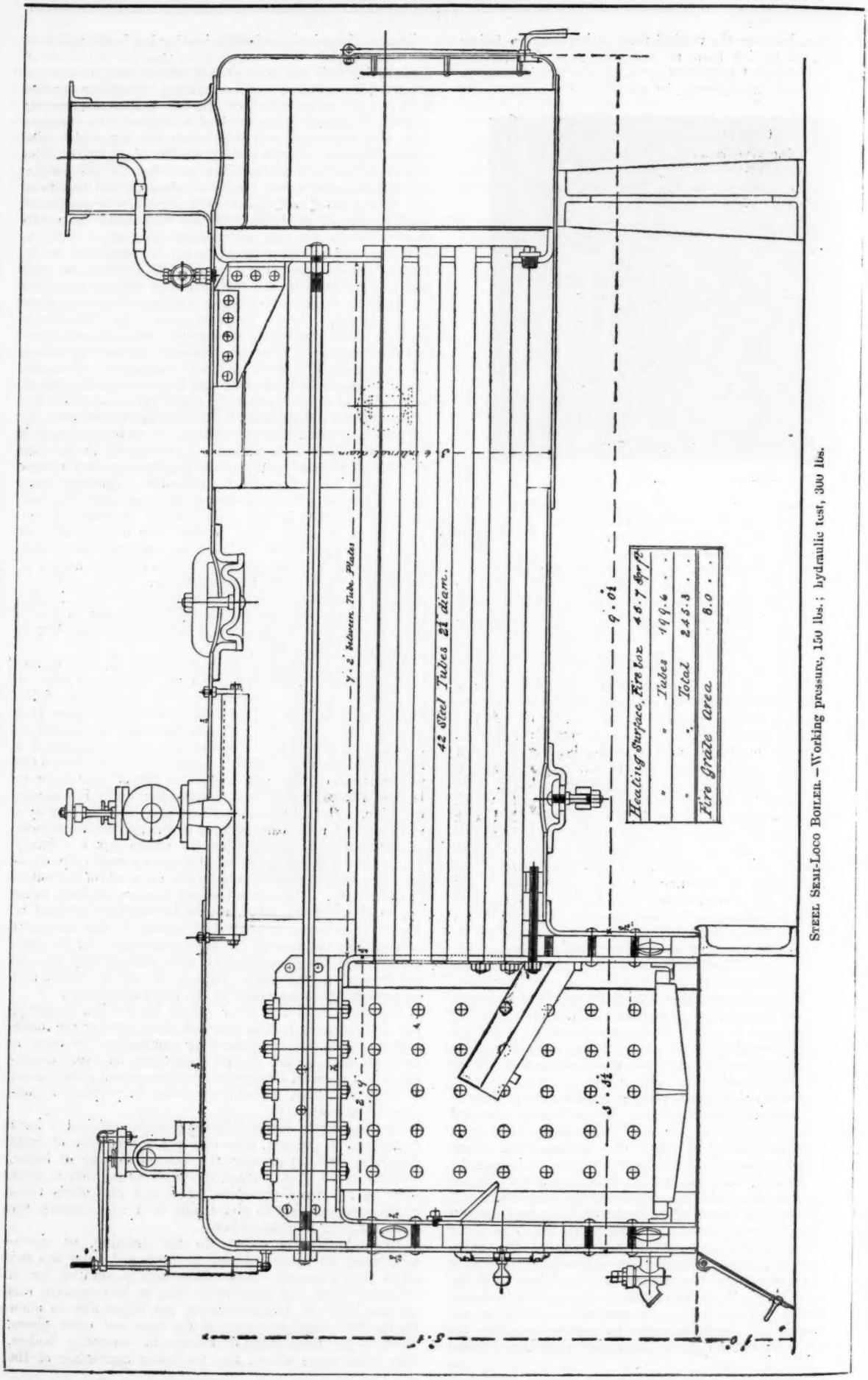
When a locomotive type boiler is heavily fired, it may happen that the heating surface, being too small to absorb the heat generated in the fire box, allows the smoke box to become exceedingly hot.

This is no indication that there is undue heating of any part of the boiler, any more than the existence of flame in the external flues of a Lancashire boiler is evidence of the same, though it is, as in the latter case also, evidence that heat has been produced which is being wasted by passing to the chimney at too high a temperature. The addition of a feed heater would prevent this waste, for it would absorb the serious excess of heat, and enable the rate of combustion to be also reduced. The feed heater thus works in a double direction. The mistake in ordinary practice is to employ a smoke box of mere bare plate, as in the locomotive, without any protective lining, and from the smoke box a chimney rising directly upwards, or in other cases a smoke pipe opening downwards to a flue running under the whole of the boilers in the battery. The smoke box and door are advisable as an aid to cleaning the tubes, but the box ought to be lined to prevent it radiating an unpleasant amount of heat, as well as covered, like the rest of the boiler, externally, for the same purpose, and the gases from the whole battery may then be led through a feed heater common to all the boilers in a battery exactly as described for the Lancashire boiler.

Not only should the lower part of the fire box be roomy, but also the upper portion in which, after passing the brick arch, the gases may complete their combustion, for there is no combustion beyond the tube plate, and any such contrivance as a so-called combustion chamber, placed after a series of small flue tubes, is absolutely useless for purposes of continued combustion.

For a moderate degree of forced draught sufficient to burn from 50 to 70 per cent. more coal per square foot of grate than with ordinary draught, the locomotive type of boiler, with 20 feet of grate surface, should do pretty well as much work as a 7 feet Lancashire boiler, and as regards tubes might have sufficient to give a ratio of 1 : 40 between the grate and total heating surface.

In a locomotive owing to the framing, as above-mentioned, the space between the inner and outer fire box shells is very narrow. Such narrowness is uncalled for in stationary work, and unadvisable also, as by increasing this the stud stays are lengthened, and are better able to allow for the differential expansion of the inner and outer plates, which is the main cause of trouble in locomotive boilers. The wider space allows, too, for better circulation of the



STEEL SEMI-LOCO BOILER.—Working pressure, 150 lbs.; hydraulic test, 300 lbs.

water, and this is very essential to longevity and freedom from fire box troubles, which points require to be specially considered by electrical engineers. The foregoing will be better understood by a reference to the accompanying drawing of a locomotive type boiler of medium size.

The makers of this boiler, Messrs. Nicholson and Sons, of Newark-on-Trent, have not designed this special boiler for a heavy forced draught. With a grate area of 8 square feet it has the ordinary heating surface a trifle over 30 times this, or 245·3, for which purpose a comparatively small number of tubes of fair diameter is sufficient.

Between the fire door and the grate level there is room for a fire quite 12 inches thick, thinner than which, except for very small coal, it is as well not to work if economy is an object. There is a brick arch, and a deflector plate in the door with an air register for smoke prevention.

With a boiler of this type at least 20 lbs. of coal may easily be burned per square foot of grate per hour with natural draught, and it is doubtful if, with ordinary coals, this type of boiler could be much improved upon for a working pressure of 150 lbs., the material being steel throughout, and the details of staying and fittings well considered.

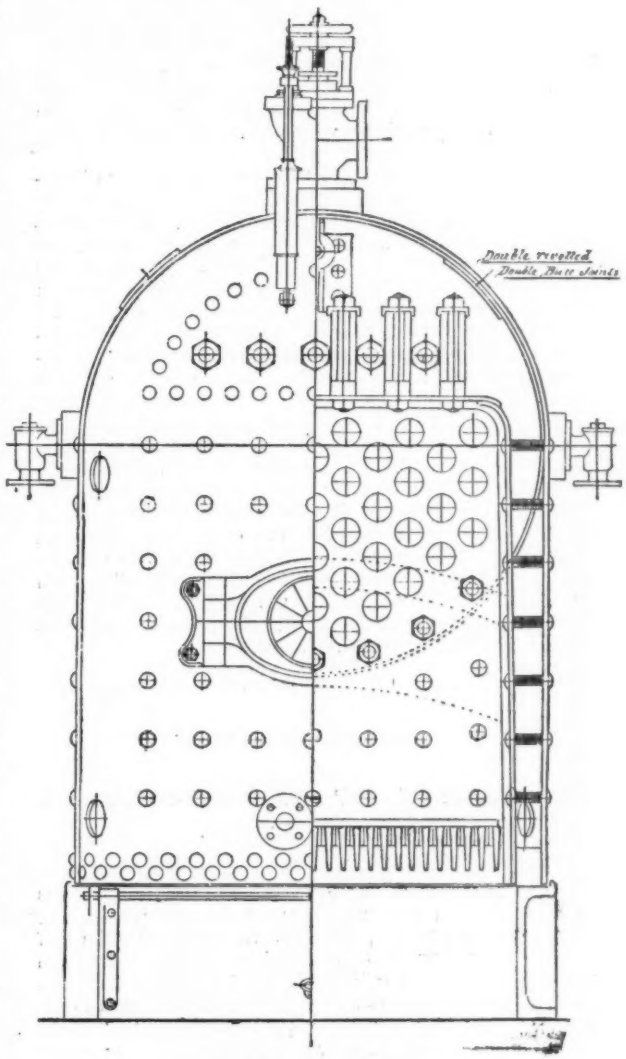
The evaporative power of such a boiler from and at 212° should be about 1,500 lbs. per hour, and thus it should be available to supply steam to an engine of from 60 to 100 horse-power indicated. The latter figure would, it is true, suppose a very high class type of engine using only 15 lbs. of water per hour per horse-power, but such a figure is by no means unknown in practice.

Probably a battery of such boilers might be called on to supply an average of 80 horse-power each with good attention and surroundings, but of course the test of a boiler is merely its turn-out of dry steam, not the horse-power obtained from it by a steam engine, which may be so very variable a quantity. Placed 5 feet apart, centre to centre, each boiler occupies a space of 70 square feet, its overall length being 14 feet. To this has to be added space at the rear for firing, and at the smoke box end for cleaning purposes. The latter must be at least 5 feet to allow of the use of the tube brush or scraper, and the former cannot well be less than 6 feet. The total length is thus 25 feet by 5 feet in width, or 125 square feet per boiler. On this basis, this type of boiler is not more economical of space than a large size of Lancashire boiler, but it avoids the building of brickwork flues, and has many advantages for certain conditions, and when intended for natural draught, and not overcrowded with tubes, has a pretty fair water capacity.

When a forced draught is intended, such a type of boiler may still be employed with the modifications previously indicated.

The fire grate would be placed lower, that is, a greater distance below the lower part of the barrel. This, of course, necessitates a deeper continuation downwards of the fire box sides, so that the fire bars may be further from the door whose position depends upon that of the brick arch, which cannot be higher than the lowest row of tubes.

With a deeper box we should obtain that depth of fire which is necessary to carry the heavy draught. The increased ebullition, due to more rapid and intense combustion, will demand that the water space between the fire box and its outer shell, which is sufficient at 2½ inches in a natural draught boiler, should be at least 3½ inches, or even 4½ inches, so that steam may better escape as formed, and overheating of the plates be avoided. For equal grate area, we find that forced draught demands a greater external breadth and a greater length and height of fire box casing. This, to some extent, gives us increased fire box heating surface, but the bulk of the additional heating surface must be got by additional tube surface, to which end we should increase their length and number while reducing their diameter. For the 20-lb. rate of combustion, we have found, per pound of coal burned per hour, this boiler affords about 1½ square feet of heating surface. If by an assisted draught we doubled the coal consumption, we should still require about, let us say, one square foot of absorbing surface per pound of coal burned, and we may suppose, as a first trial, that we quadruple the number of tubes and halve their diameter. By doing this we should double their superficial area. But we should still have only the same passage area through them for the gases, whereas we should have nearly double the volume of gases from a double rate of combustion. Properly speaking, the forced draught, if well applied, would only add, say, 50 per cent. to the previous volume of gases to be dealt with. A nearer approximation, and one giving more reasonable diameter of tube, would be to treble their number, take a third from their diameter, and thereby add one half to their cross area, whilst nearly doubling their superficial area. It would probably be found that this could not easily be worked in, and that some of the superficial area would have to be obtained by additional length of tube, whilst some addition would be made to the diameter of the barrel of the boiler, in order to make room for a greater number of tubes, the small diameter



STEEL SEMI-LOCO BOILER.
Working pressure, 150 lbs.; hydraulic test, 300 lbs.

of which, and a closer packing together, will afford a portion of the additional surface. In a battery of boilers specially forced, it is, however, very desirable that some of the heating surface should be separate and colder than the boiler, so as to utilise the final waste heat better than can be done by the surface of a boiler containing very hot steam and water.

In the boiler illustrated, the ratio of grate to heating surface is a little over double that usual in locomotives. With moderately forced draughts, the tube area need not therefore be increased in proportion to the coal burned, if we may reason from good practice; but engineers calling upon boiler makers to specify what they propose to afford, require to give some thought and attention to these points. It will be observed that about 1 square inch of cross sectional area of tubes is allowed in the boiler illustrated for each pound of fuel per hour which is intended the boiler should be allowed to use.

That is to say, approximately the tubes have one-seventh of the grate area for the passage of the products of combustion.

Though very long tubes are not specially advisable, a forced draft indirectly demands them; for it is well to add a little to the length of the barrel of the boiler, in order that the point from which steam is drawn may be well removed from the fire box, where, ebullition being violent, might induce priming. A longer barrel would permit the anti-priming pipe to be further removed from the fire box.

With reasonable attention to such points, this type of boiler, properly designed for its draught, should prove very satisfactory. Probably no boiler is much worse as a smoke producer than is this type without the brick arch, which is an essential feature and should never be omitted.

In its larger sizes the space occupied per horse-power is less than that found for the small boiler illustrated, for addition to breadth and length of fire box by no means calls for correspondingly increased general dimensions, a grate area of 16 square feet by no means indicating a total length of 28 feet or any addition whatever to the length of firing floor.

Large boilers of the type are very good as utilisers of comparatively inferior fuels. Indeed all fuels appear to be better consumed upon a large area of grate. Large grates afford also facilities in firing so as to prevent smoke, and are to such an extent preferable. Their area being largely due to width and not to length, as with the narrow grates in Lancashire boilers, it is easier in them to secure an area in a single furnace of 20 or 25 square feet than it is in a reasonably long fire of the Lancashire or Cornish type, which cannot well be over six feet in length, even when so much as three feet in breath, which is wide for a Lancashire furnace.

Clean water, free from scale-producing ingredients, is more a necessity for locomotive type boilers than for more accessible forms, and where dirty water must be used inaccessible boilers are not to be advised unless means of purification are adopted. This type of boiler has been here dealt with at rather great length, because it is one of the least understood in stationary practice and is found working over so great a range of duty. It has not proved an unsafe boiler when reasonably cared for, but has the disadvantage that the interior of its barrel is inaccessible for inspection and this unfits it for use with corrosive waters.

(*To be continued.*)

THE HISTORY OF TENSION-REDUCING TRANSFORMERS.

An American patent, recently granted in the United States to Messrs. Marcel Deprez and Jules Carpentier is attracting great attention just now, as it seems to include all systems of distribution by means of alternating currents. Although this American patent is dated March 15th, 1892, and numbered 470,865, the claims in it hold good according to the law of American patents since March 3rd, 1881, the date of the invention, at which time Messrs. Deprez and Carpentier obtained a French patent expressed as follows: *Patent No. 141,464, dated March 3rd, 1881, granted to Carpentier and Deprez, for a system of transporting electricity to a distance and transforming it.*

"The essential object of our invention is to transport electricity to a distance, with as little loss of power as possible during the transit. This invention is based upon a fact, the existence of which was discovered by M. Deprez.

"When we send into the thick wire of a Ruhmkorff coil a quantity current coming, for instance, from one or from several Bunsen elements, we determine the production in the small wire of a tension current, capable of overcoming great resistance and of being sent to a great distance without appreciable loss of power. If we then receive this tension current at the end of its course into the small wire of a second coil, it determines the production in the large wire of a quantity current which has almost as much energy as the quantity current which acted on the first bobbin. Thus the Ruhmkorff coil is reversible. We were thus able, with two Bunsen elements, to heat to red heat a platinum wire several hundred kilometres off, whereas a great number of elements would have been required in order to obtain the same result if the communication between the battery and the wire had been direct, for quantity electricity loses a great deal of its energy very quickly, if a resistance is opposed to it. Thus it is by transforming quantity electricity into tension electricity by means of an induction coil, that we arrive at the transport to a distance of electricity: the electricity thus transported will be employed either as tension electricity or quantity electricity, by using a coil at the receiving station. To sum up, we claim:

"1. The means discovered by us of transforming a quantity current into a tension current by means of the induction coil, and of re-transforming this tension current into a quantity current, the coil being reversible.

"2. Tension currents being capable of overcoming high resistances and traversing long distances without losing their power, the arrangement of one bobbin at the starting point of the current, and of another at the arriving station, as far off the first as is required, the first transforming the quantity electricity into tension electricity, which is at the end of its course reconverted into quantity electricity, thus enabling the electrical force to be transported to a distance."

The American patent, which is in accordance with the above description contains several fundamental clauses, one of which is as follows:

"An improvement in the art of transmitting electrical energy and utilising it at a distance from its source, consisting in the production of high tension currents that are practically uniform, and that are kept so at one station and their transmission along a conducting line to another station, and the production at that station of currents of lower tension that are practically uniform, and are kept so by the influence of high tension currents."

It is worthy of notice that this clause in the American patent is much more expanded than the corresponding one in the French patent, in which the fact of transforming low tension currents into high tension currents is always referred to as one of the main points in the method patented. Perhaps neither M. Deprez nor M. Carpentier have ever had any idea of claiming as their invention anything more than was described in their French patent.

The American patent, however, by a clever reserve and a careful mode of expressing the claims, has been drawn up so as to cover any system of distribution in which alternating high tension currents, no matter how they are produced, are sent along the line and reduced in tension at the distributing station by means of an inductive transformer. This patent, when carefully analysed, practically covers the reversibility of the induction coil, and for this reason it will be interesting to study the history of this discovery.

Although the writer of this article (Mr. A. M. Tanner, in *L'Industrie Electrique*), has shown in the *Electrical World* for April 25th, 1887, that Deprez and Carpentier ought to be considered, in virtue of their French patent of April 5th, 1881, as the first to propose the application of the reversibility of the induction coil to a system of electrical distribution, fresh researches have shown him that the idea dates much farther back than 1881. This is, in fact, clearly proved by the following extracts, all taken from French sources:

"A French patent was granted to Alcide Girin, on September 10th, 1875, No. 100,282, relating to the combination of an electro-magnetic inductive apparatus and a certain number of induction coils *in order to obtain in the secondary circuits a lower tension and a higher intensity than in the primary circuits.*"

In other words, Girin in this patent describes induction coils in which the induced wire is a thick wire instead of a fine wire, as in the Ruhmkorff coil. The description establishes that. The magneto-electric inductive apparatus will create currents that will be sometimes of one kind and sometimes of the other. By means of these currents the Ruhmkorff coil, R^1 (figs. 1 and 2), will be induced.

The coil, R^1, will actuate a second, R^2, and so on, only as the induced currents are stronger than the inducing, the more bobbins there are used the stronger currents we shall have. In the last bobbin, as the currents may become very powerful, *thick wires are to be used, even for the induced currents.*

We see that Girin's electro-magnetic generation consists

of a solenoid in which an inductive magnet moves. Necessarily, such an apparatus will create alternating currents, which may be transformed into currents of greater intensity by means of induction coils capable of working without interrupters or rheotomes.

The currents when thus transformed and suitably commutated were used mainly for working a motor of a special construction, indicated in the patent, and, moreover, the

FIG. 1.
A, Oscillating inductive magnet.

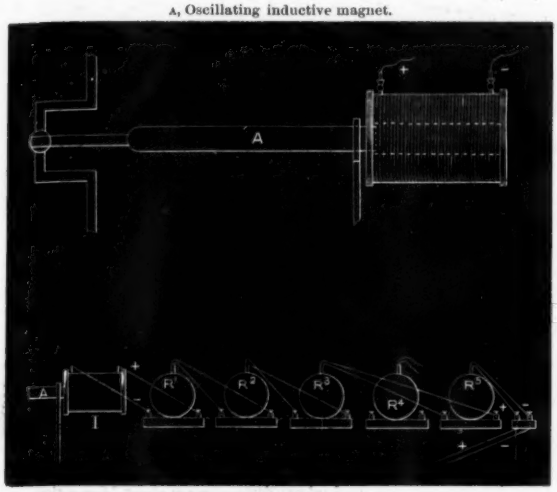


FIG. 2.
GIRIN'S ALTERNATING GENERATOR AND APPARATUS FOR OBTAINING CURRENTS OF GREAT INTENSITY.

description establishes that "the generator may also be used for the electric light by making the current pass through a known apparatus constructed for that purpose."

In the *Annales de Chimie et de Physique*, A.D. 1875, Vol. vi., p. 391, we find a paper on "Induction," by M. E. Bichat, professor at the Lycée, Versailles,* from which we quote the following passages :—

"The Ruhmkorff coil must be the apparatus best adapted to the transformation of static electricity into dynamic electricity. If, in short, we pass a series of sparks of static electricity produced by a Holtz machine into the fine wire of the bobbin, we obtain in the thick wire induced currents, which are distinguished from all the other induction currents produced with static electricity by the extreme facility with which they decompose water and saline solutions.

"Instead of producing the sparks of static electricity by means of a Holtz machine, they may be produced by a second Ruhmkorff coil. This second coil was made to work by means of three Bunsen elements, its poles were put in communication with the extremities of the fine wire of the first bobbin. This experiment shows, in fact, that the current of a battery is transformed into sparks of static electricity and later on these same sparks of static electricity are transformed into a current producing effects analogous to those which would have been produced directly by the battery serving to excite the second bobbin. It is worthy of remark that the decomposition of water by the induced currents developed in the thick wire of the trial bobbin, is incomparably more rapid than that which is observed when we put the extremities of the fine wire of the auxiliary bobbin into direct communication with the same voltameter."

We can see that Bichat's experiments with a battery and two induction coils practically anticipate the methods laid down in the French patent taken out by Deprez and Carpentier, since there can be no invention in the establishment of circuits between the two long or short induction coils.

A French patent granted to Maiche, October 7th, 1880, No. 138,715, relates to a system of transmission of telegraphic dispatches consisting of, A, transforming at the starting point, the low tension quantity current proceeding from the battery or telephone into an induced high tension current, capable of overcoming the resistance of the line and then re-transforming this induced high tension current on its arrival into a quantity current acting directly upon the receiving apparatus, or upon a relay which puts in action a local battery.

"To do this I proceed generally as follows : I place at each of the points to be put in communication an ordinary induction coil, a Ruhmkorff coil.

"The fine, or induced, wire of each bobbin is put into communication with the fine wire of the other bobbin by the line established in the ordinary way, with a single wire and the earth or with two wires. The despatching and receiving apparatus and the battery, if there is sufficient space, are placed at each station in the circuit of the thick or inductive wire of the bobbin.

"It will be seen, then, as I have said, that what specially characterises my invention is the reception of electric currents into an induction coil, which transforms the very weak high tension currents sent into the line by the fine or induced wire of the bobbin at the starting point, into currents of low tension, but of greater quantity much more easily collected and utilised."

One of the claims is worded thus :—"The adaptation of this system to all kinds of apparatus destined for electrical transmission, of any nature whatever."

From this it follows that Maiche does not confine the application of his system to telegraphy or telephony, but on the contrary points out that it may be adapted to electrical transmission of any kind. It does not appear, however, that the currents sent along the line are uniform in themselves, or are maintained uniform. In all other points, however, his patent is the same as Deprez and Carpentier's.

Another example of the reversibility of the induction coil, earlier than the well-known patent of Gaulard and Gibbs, is :—

Patent No. 142,521, *dated April 26th*, 1881, *granted to the Société Générale d'Electricité (Jablochkoff methods) for a system of incandescence lamp, with directing circuit.*

This is a modification of the kaolin lamp, fed by the electric current of an induction coil or high tension machine.

The modification consists in the employment of a circuit called the directing circuit surrounding the porcelain plate.

The description mentions that "a high tension current is necessary to feed the lamp ; but it is not necessary that the current of the directing circuit should have as high a tension ; in fact, it is expedient that the tension should not be so high, as this enables us to reduce the insulating material of the wire of the directing circuit. We can, for this purpose, arrange the bobbin feeding the lamp as shown in fig. 3. The wire surrounding the core of the inducing wire is divided into two lengths : the first, *g*, formed of fine wire, furnishes the current which passes through the porcelain plate ; the second, *g'*, formed of thick wire, furnishes a current of lower tension which is sent into the directing circuit outside the plate. The directing circuit serves to light automatically the porcelain plate."

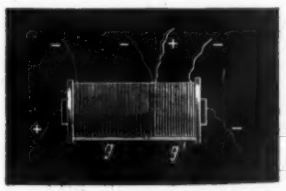


FIG. 3.—JABLOCHKOFF'S TENSION REDUCER.

We see that this patent specifies the employment of an induction coil with two secondary bobbins, one of fine wire, the other of thick wire, the latter serving to reduce the tension of the primary current sent into the coil by an alternating machine. As is well known, Jablochkoff's original system of distribution comprises the employment of induction coils mounted in tension on an alternating current circuit. The original Jablochkoff patent of 1876 does not mention the induction coils for reducing the potential, and, indeed, the plates of porcelain required currents of very high tension in order to be brought to a state of incandescence. It follows, nevertheless, that at this date of April 26th, 1881, Jablochkoff recognised the fact that an induction coil, the secondary wire of which was thicker than that of the primary bobbin, reduced the tension of the current sent into the primary circuit.

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* Now Professor at the Faculté de Nancy.

THE TELEPHONE AT HOME AND IN THE FIELD.*

BY MAJOR C. F. C. BERESFORD, R.E.

Origin.

The telephone may be said to have been invented in 1876, by an American gentleman, Professor Graham Bell.

In 1877 Mr. Preece, well known to all of us as the author of the latest telephonic triumph, the London-Paris telephone line, having been to America, brought back some of the instruments, and, in the same year, exhibited them to the officers of the telegraph troop, in the R.E. theatre at Aldershot.

This was the birth of the military telephone.

The Microphone.

Following close upon the telephone came the great invention of Prof. Hughes, which at once opened the door to its practical employment. This was the microphone.

The microphones with which we have to do in the Service consist of pieces of carbon placed in loose contact in the circuit. The vibrations of the carbon caused by the voice produce corresponding variations in the current of a battery attached, and the loudness of the transmitted sounds depends on the amount of these variations.

A small battery is a necessary adjunct of a microphone.

"Calling" Apparatus.

In addition to the telephone and microphone, we also require a means of calling the attention of those at the distant end of a line. There are various ways of doing this. But in dealing with military movable telephone systems, the chief difficulty is to devise an efficient "call" apparatus which will not involve the use of a battery or any bulky or delicate machinery.

The call may be made either by bells, by a vibrating sounder, or by the reproduction of various sounds in a distant telephone, using for the purpose, reeds, whistles, or vibrating instruments.

The bell is the appliance which gives the most distinct call, but it requires either considerable battery power or a magneto machine to ring it.

The reed is independent of extra power, but its sound, received on the distant telephone, is comparatively feeble.

A telephone installation complete thus consists of three distinct and principal parts, *i.e.*, the telephone proper, the microphone with its battery, and the calling apparatus.

Its development in England was long delayed by the fact that the patent rights were all in the hands of one company, but, now that these rights have mostly expired, we may hope for rapid improvements and simplifications both in the instruments themselves and in the methods of using them. This view of the matter is of special importance to the growth of Army telegraphy, where simplicity for the soldier and economy for the exchequer are the two things needful.

The telephone, in its complete form with microphone and call apparatus, is a more or less delicate instrument, and requires an intimate acquaintance with its idiosyncrasies to keep it in good working order.

If we propose to extend the telephone for field service, and introduce it as an article for general use in the hands of the soldier, some simpler form is necessary; in fact, we may not hope to introduce any such apparatus which does not combine extreme simplicity with extreme cheapness.

Specimens of Instruments.

The following are some specimens of the instruments and appurtenances at present available in the military service, which were shown by Major B.

1. A telephone in its original simple form.
2. The "Ader" telephone, transmitter, and receiver.
3. The "Ader" receiver combined with a vibrator.
4. The "Ader" receiver combined with a Morse key.
5. The "Berthon" transmitter.
6. The "Operators" telephone.
7. The "Gower-Bell" telephone.
8. The "Siemens-Halske" telephone with "reed" call.
9. The "Aubry" telephone (French Service).
10. A "trembling bell."
11. A "magneto call."
12. "Exchange" switch.

The "Ader" receiver, which is a modification of the telephone in its simplest form, can be used without a microphone, on short lines, as a speaking instrument, but is only of very moderate power when so used.

Its great value, however, appears when in combination with the instrument familiarly known as the "vibrating sounder," or "buzzer," a system, introduced some years ago by Major Cardew, which enables communication to be held under circumstances when every other form of telegraph would fail; by its means signals can be sent through bare wire lying on the ground, and even in water, while in India some successful experiments have, by its aid, been carried out in telegraphing without connecting wires across rivers.

The "buzzer" may be called the backbone of British field telegraphy. When a microphone is added, the combination can then be used at will for speaking, or for communication by Morse signals.

The "receiver" used in connection with a Morse key is, perhaps, the simplest form of all telegraphic apparatus; it was tried some years ago at Chatham, but difficulties were experienced in reading, on account of the make-and-break "clicks" being so similar in sound.

Late experiments at Aldershot have, however, shown that this difficulty is got over, and signals have been read with ease through a resistance of 4,000 ohms, and through field cable circuits, using only one field service battery cell, such as might be carried in a man's pouch.

The "Ader" apparatus complete, *i.e.*, telephone and microphone, is one of the best at present existing for speaking purposes. It has given excellent results during the last year at Aldershot for work between the various temporary camps, on the New Ash ranges, and on the "Exchange" systems during the manœuvres. It is not so portable as the "Operators" telephone, but speaks louder.

The "Berthon" microphone, or "transmitter," in which the carbon takes the shape of small pellets between two plates of the same substance, is of a very portable form, and is also useful for telephones in forts where the firing of heavy guns is apt to break the carbon pencils in the other pattern of microphones.

The "Operators" telephone is a combination of the "Berthon" microphone and the "Ader" receiver, these two being fixed to one handle.

The "Gower-Bell" telephone is, perhaps, the most powerful instrument of all; it is that used by the General Post Office, but its size prohibits its use as a field instrument.

The "Siemens-Halske" pattern has been a good deal used in foreign armies, and is at present in use with our balloon service, though it will, no doubt, be superseded by the "Operators" telephone.

The "Aubry" telephone, from our experiments at Aldershot, appears to give as good, if not better results than the "Ader" receiver. It is the pattern of receiver used in the French army.

The principal method hitherto adopted of calling a distant station is the "bell" rung by battery power. This is inconvenient for military purposes in the field, owing to the size of the battery necessary, and the "magneto call" will be adopted for telephone stations.

Calls can also be effected by means of the vibrating sounder, or by the use of reeds, as in the "Siemens-Halske" instrument. The "reed" form of call, being the simplest, would seem to be that most suitable, if sufficiently audible, for the future development of telephones for outpost work, and where distances are short Morse signals can be transmitted by reed, as by key or "buzzer." Considering, however, the comparative feebleness of the calls, some contrivance for fixing the telephone against the ear might be found desirable.

"Exchange" Telephone Switch.

The switch used last year during the manœuvres was of the G.P.O. pattern, but the new form arranged by Major Bagnold is that sealed for use in the service.

The Post Office pattern has the advantage of being more compact, and of being fitted for double wires; Major Bagnold's switch, that of dispensing with the connecting cords for the pegs.

To give a telephone fair play, double wires are often necessary, especially when vibrators are in the neighbourhood, or when the wires of the circuit run on the same poles as those of other circuits.

Under this consideration, I consider it very doubtful whether the G.P.O. pattern would not be the most serviceable in the field. No disadvantage has as yet been found in the use of the cords connecting the pegs, the absence of these being claimed as the chief advantage of the other forms.

Comparison of the Telephone with Telegraph Instruments as a Means of Communication.

It might appear at first sight that, in a matter of pace, a telephone used for speaking had great advantage over one used for Morse signals, or over a telegraph instrument. But practically, for written messages, the pace is limited to the writing pace of the receiving clerk.

We know that 40 words per minute is practically the utmost limit for first-class receiving on a sounder, hand-speed, circuit.

The Wheatstone fast-speed instrument used in the Post Office has certainly an output of 300 or 400 words per minute, but it is fed at the sending end by a number of men, the individual work of whom, being taken into consideration, would not exceed 40 words per minute per man employed. Forty words per minute is also the practical limit of pace in writing out a message, and 30, or even 25, would probably represent the average.

Now the human voice could send a message at the rate of from 150 to 200 words per minute, but although this might possibly be received on a good telephone, it could not be written down except by shorthand. We cannot, as yet, say how far the phonograph may help us for recording telephonic messages, but the phonograph could scarcely enter into consideration for universal use in the field.

Further than this, the telephone at present does not carry the voice so distinctly as to make it reliable for quick work.

From practical experience at Aldershot, when in some of the divisional offices both telegraph and telephone are working side by side, there is no doubt of the great superiority of the sounder over the telephone circuits for carrying traffic.

On the other hand, the telephone circuits require little or no special qualifications for the clerks employed, while, for the military sounder clerks, picked men and a training of from four to six or nine months are necessary even for second class offices.

From the foregoing it appears that the following, if brought about, would be a way of increasing the carrying power of ordinary telegraph lines, perhaps up to five times:—

1. Improved telephones.
2. A more widespread instruction in shorthand writing.

The first we may look upon as a future certainty, the second as a matter of elementary education.

* The Royal United Service Institution, read Friday, February 19th.

At the present time the instruction of shorthand is on the increase, and such are its uses that we may hope one day to see it taught in every school.

Pending these suggested improvements we must pin our faith on Morse signals for the more important work.

The reading of these is very easily attained by children and boys up to the age of eighteen, and, as the Service at present is not altogether without the latter, there would not seem to be any insuperable difficulty in obtaining a sufficient number of Morse clerks; and it is to be remembered that the telephone, as a Morse receiver, is a far more sensitive, economical, and simple apparatus than any telegraph instrument in use.

The telephone, as a speaking instrument, in its present state, is rather more suited for conversation than for the transmission of important military orders; at any rate in the field. Its importance in this respect is most marked under circumstances where queries on minor details demand immediate replies, as is the case in local transactions with our supply services; and here comes in the advantage of a telephone exchange.

But for use on the main line of communication, or for outpost duty, except under exceptional circumstances, the effective use of the telephone for speaking is doubtful.

When and Where to Employ the Telephone (for speaking).

Having seen what telephonic appliances are available, what is to be expected and what is not to be expected from the telephone, attention may be next directed to the consideration of circumstances under which it can be profitably employed for Army purposes.

These may be generalised under the following headings:—

1. Telephones and exchanges in garrisons.
2. For coast defence, including artillery, submarine mining, and general purposes.
3. On rifle ranges.
4. On artillery ranges.
5. For siege operations.
6. Main lines of communication in the field.
7. Intercommunication in camps.
8. Outpost duties.

In Garrisons.

For garrison work the use of the telephone is obvious; it is employed at all our garrisons and dockyards at the present moment, and its great extension merely a matter of time.

For Coast Defence.

Having had no personal experience of the telephone for coast defence, I hope some of the officers here will give us their views as to its present use, future development, and forms of apparatus most suitable.

On Rifle Ranges.

During the spring of 1891, telephone lines were erected along the three new rifle ranges at Ash, near Aldershot; the instruments used up to the present time are "Aders" (transmitters and receivers), these, as I learn from the Inspector of Musketry, Major Crabbe, have given such good results that the extension of the system to all ranges may be confidently looked for.

On each range the circuits run from the butts to various firing points, and each range is also in connection with the caretaker's hut and with the camp at Aldershot.

The movable instruments and batteries are fixed in a species of sedan chair, which is carried from firing point to firing point as required.

(*To be continued.*)

ELECTRIC AND CABLE RAILWAYS IN THE METROPOLIS.

AT the meeting of the committee on Wednesday last week (Mr. Stansfeld in the chair),

The CHAIRMAN said it was thought desirable to have evidence as to the provisions for the disposal of the subsoil while the railways were being made.

Mr. WOLF BARRY, consulting engineer to the Metropolitan District Railway, as well as adviser to the Corporation of London, said the interests of the two bodies in these matters did not clash, except in minor matters, and he did not oppose the preamble of the Bills. The Corporation of London instructed Col. Heywood and himself to report on four of the six railways, from a public point of view, and they did so. The first question was what the depth of the tunnels ought to be, and he said it should not be less than 10 feet below the undisturbed portion of the London clay. If the tunnels were put into the water-bearing strata, the problem would be very different and far more difficult, and the houses adjoining would be affected by subsidence of soil. The second point was the width of the tubes. Legislation hitherto had been somewhat haphazard on this subject. The tubes of the present South London line were to have been 10 feet in diameter, according to the Bill, which also said it was to be a cable railway, though it was subsequently fitted with electricity. Since then another Bill had been passed, sanctioning 11 feet tubes, and there was another Bill which put the diameter at 11 feet 6 inches. In the present Bill there were tubes of 11 feet 6 inches, 12 feet, and 16 feet. The larger the tube, the greater the expense in making the line, and the reason why engineers had advised the smaller sizes was because the others were so expensive. Witness added—I am in favour of uniformity in the size of the tubes, which ought to take in ordinary rolling stock. The third question was the adequacy of the proposed railways. I don't think they can be expected to carry the traffic as conveniently as the ordinary railways. The fourth matter was as to safety, and we think the question of junctions should be considered with a view to the future wants of the City. It is the custom to look upon the Inner Circle Railway as being strictly urban, but that is wrong, as it serves the suburbs as well as London. I show you a diagram in proof of that statement. The urban trains run every 10 minutes; but there are other trains to Ealing, Richmond, Hounslow, Wimbledon, &c., the result being that the suburban trains are 12, and the urban six in the hour. In view of these circumstances, Col. Heywood and I think that the importance of making the lines so as to admit of junctions cannot be exaggerated. The fifth matter laid before us was as to the companies being permitted to use any portion of the public way, so as to give access to their stations. We think that unless absolutely necessary, it should not be allowed. Other railway companies have had to pay for such privileges. The companies propose to give the public some *quid pro quo* for that convenience; they would allow them the use of the subways to move from point to point. It is a question with some whether the work could be carried on without stoppage to traffic. If a failure of works takes place, the companies are liable. As to the proposed central station at the Mansion House, the spot is so congested we do not favour it. There would be three termini there, which would increase the foot traffic greatly.

The CHAIRMAN: Have you proposed any alternative?

WITNESS: No; that does not come within our province. There would be such a concentration of traffic that we look upon it with considerable alarm. The stations would be in shafts sunk into the London clay, but there would have to be a subway 15 feet wide in the upper soil, in which there are many gas and water pipes. We think, generally, that the routes are good ones, subject to what I have alluded to. The last point, a very important one, is as to the size of the tunnels. I have had considerable experience in railway matters, and I am quite of opinion that the lines should admit of taking the ordinary rolling stock of the country. If they are not, it will cause a break in continuity, which it is desirable to preserve. In India, the narrow and the broad gauge lines are kept quite distinct. It is, of course, said that these lines will be so deep that it does not matter, but that is a narrow view. It would be a great mistake to make railways the trains of which could not be used on the ordinary lines. If you look at the map you will see that the junctions will be desirable, and it seems to me very serious to make lines that cannot be joined to others; the only objection is on the score of cost. I have looked into this, and do not quarrel with the statement of Mr. Greathead that the extra cost of the bigger tunnels would be £100,000 per mile, minimum. It would be money well spent, not only in the interests of the country, but of the companies. A railway that will take any ordinary traffic is, I think, worth twice as much as one that can deal only with urban traffic. The urban traffic of the present underground companies scarcely pays, and if it were not for the suburban traffic we catch with our lines that run into the country, there might be a stoppage.

Lord KELVIN asked about the air currents in the tunnels.

WITNESS: The larger your carriage in the tunnel the greater the air resistance. The worst tunnels to ventilate are the long, single ones. I have never heard that there is inconvenience in ventilation on the South London line. One of these railways is to be worked by rope. This should be carefully considered; we desire uniformity. The rope line would be cheaper, but I would give the preference to the electric lines. I don't think you could expect that the electric lines would give more trains per hour than the Metropolitan District does, and that gives 20 trains per hour on ordinary occasions, with about 25 at special times. There is no place in the world where large trains are more needed than in London; the Metropolitan District meets this want. In some respects, the larger tubes would work more cheaply than the smaller. The minimum I would allow is 15 feet. All the rolling stock of the country would, I think, go through a 15 feet tube.

Lord KELVIN: Would you still have an iron tube?

WITNESS: Oh, certainly. It would not be safe to line tunnels at so great a depth with brickwork. I appear for the corporation; I do not advise the throwing out of the Bills. It would be a pity if the Bills were abandoned, but it would be a greater pity if Parliament went wrong in the matter. I am aware that the railways are designed to meet passenger traffic, but they might deal with goods traffic at night. The lines would carry traffic which would be numbered by millions, no doubt, and they would therefore relieve the traffic in the streets. I say that the lines will do a great deal of good, but I criticise the size of the tubes.

Lord THRING: You do not wish them to be connected with existing lines at once, but say they should have the necessary capacity.

WITNESS: Yes. If you say that the connection is to be made at once, it will be tantamount to the throwing out of the Bills. I think it would be cheaper to make the larger tunnels at once. It would not be practicable to run the rolling stock of the new lines over the ordinary railways; you would have to alter the platforms of the existing railroads if you tried it. It would not be a wise thing to cut these railways off from the other railways of the country by allowing the 11 feet or 12 feet tubes, any more than by allowing a narrow gauge on ordinary railways.

Lord THRING: You are the engineer of the District Railway, and you want it to continue.

WITNESS: I am. The fact that the Great Northern Company contemplate a 16 feet extension shows that the cost is not too great when it meets the purposes of the promoters. I am only thinking of the future, and of the public need. Parliament made a great mistake when it sanctioned the South London Railway, the cost of which is excessive. The tendency of the large tunnels is towards cheapness.

I don't think that we know enough of the working of electrical railways to judge of the precise cost, but it seems that the electric lines are rather more expensive. I leave the future to take care of itself; if you make the tunnels of sufficient size to admit of junctions when they are required.

The CHAIRMAN: What would be the advantage in compelling these half dozen new lines to form junctions with the ordinary railways?

WITNESS: It is desirable to meet the future growth of the suburbs. The present underground passenger traffic is not increasing. An underground railway already sanctioned has not been made, because it came at a difficult time, financially. Some of the lines (including the North Western) are widening their lines to meet the congested traffic. It would be a convenience if the new lines ran out into the suburbs between the lines of the great companies. I adhere to my opinion that it would be best not to break the continuity of the rolling stock. It would rather be advisable to defer the lines than make the mistake I have indicated. A junction could be made with the South Western at some point or another.

Sir DOUGLAS FOX, joint engineer to two of the proposed lines, said: This question has been fully considered in New York, where the elevated railroad, of which there are 32 miles, will not admit the ordinary rolling stock They carry 200 millions of passengers per annum, quite independently of the ordinary lines of the country. In Liverpool, on the overhead lines, there is no connection with the ordinary railways. The system of taking outside traffic on the inner circle does not conduce to the efficiency of that line *qua* a local railway. As to the size of the tunnels, the 12 feet tubes would be a little larger at the curves. The difference in cost between the 12 feet and the 16 feet tunnels would be practically double. The capital cost of the Hampstead line would be £370,000 per mile. I am convinced that the difference of cost would be prohibitory if the suggestion that, say, the Hampstead railway be 16 feet be carried out. I don't see how it would be possible to form junctions between the Hampstead and ordinary lines—the line is for local traffic only. The Great Northern Railway has a magnificent suburban district, but its lines are very much congested, and the new line of extension is to enable them to meet the great pressure. An exchange station is more convenient than a junction for passenger traffic of this kind. If the lines have to be taken under the houses from point to point it will entail great cost. To meet the traffic it seems better to go along the street line. In any case, the tubes would have to cross the streets. At present the subsoil is valueless, whereas the new lines will give it a rateable value, and thus increase the value of the streets, over which at present the tramway companies run free of charge. The suggestion that the tubes should be at least 10 feet below the undisturbed portion of the London clay is impracticable, as the undisturbed portion could not be ascertained, in many cases, without careful inquiry. I agree with Mr. Barry that it is not necessary to make the tubes double under the river. As to the carting of the soil, in the schemes in which I am interested there would be no difficulty. It is only a question of making arrangements. In Liverpool there is an electric line. I prefer electric traction to cable. There will be ample facilities for all ordinary luggage on the new lines. The lift system on the Mersey railway is very successful, and the same system would be used here. The speed proposed is an average of 16 miles per hour. Considering the number of the stoppages it would be difficult to get a higher rate. Practically there would be no vibration on the surface, and there can scarcely be any nuisance from either noise or vibration. As to the proposed clause for the protection of private property, it is very desirable to prevent speculative actions, though there is no desire to avoid giving fair compensation. In Liverpool there have been many speculative actions. If the installation is properly carried out it ought not to be felt 40 feet off. The work will be carried out in the best possible manner, with all possible improvements, and that will prevent nuisance.

Mr. W. R. GALBRAITH was next called, when

The SOLICITOR to the Central London Railway said he was instructed to tender the evidence of Sir John Fowler to show why they had decided to keep the tunnel at 11 feet 6 inches instead of 16 feet, and to speak to other matters.

Mr. OAKLEY, representing the Great Northern Railway Company, said Sir Henry Oakley would give evidence as to the size of the tunnels, &c., if necessary.

The CHAIRMAN: We shall not take any more evidence as to the size of the tubes.

Mr. GALBRAITH said he was engineer of the Baker Street and Waterloo and one of the other schemes, and that he wished to say, in answer to the evidence of Mr. Barry, that if an underground railway was to be made between the City and Waterloo, a junction with the South Western at Waterloo was impossible. It could not be made, and if made could not be used. A junction made with the railway at Waterloo would be practically useless. It would be impossible to carry the trains on were junctions made. There were junctions already, in fact, and they were not used. The vestries had all withdrawn their objections to the Baker Street and Waterloo line. About 750 omnibuses passed the Baker Street Station daily, which showed the enormous traffic on the line. He thought the Metropolitan Inner Circle service had been spoilt by the running of trains from the outside; it would be infinitely better to confine the line to City traffic. Mr. Barry was quite wrong as to the junctions—if they were made they would not, and could not, be used. It was not necessary to confine the tunnels to the clay. With Mr. Greathead's system it was easy to run tubes through water-bearing strata without pumping—forcing the water out by air pressure, as was being done at Glasgow, under the Clyde. The largest carriages would go into the 12-feet tubes, with slightly lower wheels; and the same applied to Pulman cars. There was no necessity for it, and goods traffic ought not to be run through the centre of the City. To increase the size of the tubes would mean that many of the proposed lines would have to be dropped, as they would not pay with 16 feet tubes. It was not advisable to go out of the street line and under private property. The Duke of Portland and Viscount Portman, among others, would oppose it.

Mr. FREDERICK HUNTLEY, agent and surveyor to Lord Portman, stated that he wished to say that the subsoil should not be allowed to be acquired without compensation. The proposals of the London County Council were most objectionable. Mr. Harrison's proposition in answer to Question 400, was that no compensation should be paid, other than for actual damage done. The subsoil belonged to the proprietors alone, and its use should be subject to arrangement made with them. Like a disused coal mine, the tunnels would be a source of danger to property above.

Lord THRING: They should purchase easements in the soil, not the soil itself. If I make a drain 60 feet beneath the soil, I do not buy that soil, but an easement.

WITNESS: They should pay for permission to go through what is private property. The subsoil under the streets belongs to the owners on either side.

Mr. BOLTON: Are you sure of that? It is not a mere presumption of law.

WITNESS: I believe it is the law. I am advised to that effect.

Mr. BOLTON: What compensation should these railways pay?

WITNESS: It should be a matter of arrangement with the owners above. I am not here to oppose the Bills, but the suggestion of the County Council that the subsoil may be taken without compensation.

The committee then adjourned.

The joint committee on this subject met again at the House of Lords on Thursday, May 19th. Mr. Stansfeld presided, and there were also present Lord Lauderdale, Lord Strafford, Lord Thring, Lord Shute, and Lord Kelvin; and Messrs. Whitmore, Story-Maskelyne and Bolton.

The CHAIRMAN intimated that it was the intention to finish the taking of evidence that day.

Mr. DONALD MACMILLAN (from Messrs. Fowler & Co.), who was the first witness called, read certain sections of the Act of 1884, which authorised the construction of the City of London and Suburban Subway, and said that wherever they went under private property during the course of that work, they either made arrangements with the owners or acquired the rights of ownership: but they kept to the road line except where it was absolutely impossible. Wherever they went under private property they paid for it or made arrangements with the owners. It was the duty of the public to protect themselves. They did not receive any claims for going under the streets.

Mr. BOLTON: Don't you think very lenient terms were conceded in the first tunnel railway, it being in the nature of an experiment.

WITNESS didn't think so, he said, but the local authorities treated the company well, because it paid in rates for value that did not before exist. They have given cheap trains, and their fares were so low that the line was a great public convenience.

Mr. BOLTON: How many cheap trains have you given, distinct from your ordinary fares?

WITNESS: We have given some. There are no special clauses in our Acts to provide for what you would call cheap trains. At a certain hour in the morning workmen may travel the whole length of the line for a penny from any station but one. The length of our line is 3¼ miles, and we have from 18 to 20 of these cheap trains per day. The fares are cheaper before 8 a.m.

Mr. BOLTON: Compare that with the terms for cheap trains on other lines. On the Central London workmen can travel 6½ miles in the morning for 2d.

WITNESS: At the Oval we take them there and back for 3d.

Mr. GREATHEAD, in answer to the chairman, said the cheap train clauses in the present Bills was the same as the clause in the Central London Bill.

Lord THRING: In respect of all the lines before us now the companies claim to run under the roads without giving compensation.

Mr. GREATHEAD: No. The companies ask for power to use the land under the roads, but they would be liable to claims from the owners, whoever they may be.

Lord THRING: All you ask then is for power to run under the roads?

Mr. GREATHEAD: We also seek power to run under private property where necessary, and to obtain easements and to acquire property, if required.

Lord THRING: Have you the right to go under my property without compensating me?

Mr. GREATHEAD: The owner is to make out his own claim, and we have to meet it.

Mr. BOLTON: You may derive enormous advantage from going under the land, as in the case of collieries. Ought that not to be paid for?

Mr. GREATHEAD: The owners are entitled to make claims. There is nothing in this Act that debars them from doing so. The more valuable the lines become the more we contribute to the local rates. We take no private rights that will enable us to take the subsoil in any place without compensating. It would, no doubt, be open to an owner to obtain an injunction to prevent our going under his land.

Sir BENJAMIN BAKER said there seemed to be misconception as to many of the facts. He had been associated with Sir John Fowler in the general policy of the Underground Railway during the past 30 years. Why, for a quarter of a century, nothing had been done in the centre of London to increase the facilities for travelling, as in New York, had not been stated, nor had it been explained why New York had 40 miles of urban railway, while London had less. In New York, a business man could travel about the city at 10 miles an hour, while

in London they had to be satisfied with six miles an hour. Many plans had been proposed in London to meet the needs of the people. but they were prevented from being carried out. The reason was not far to seek. When Sir John Fowler promoted his underground railway he obtained the cordial co-operation of the public bodies and of the Corporation of the City of London. Since then these public bodies had not assisted in the same way, but sought the advice of professional advisers, and an engineer, when consulted in that way, of course always thought he must get something for his clients. (A laugh.) The Bills were so full of onerous clauses, that it was very difficult to get the money for new schemes. Sir John Fowler applied for permission to make a railway, and the City of London Corporation subscribed £200,000 to it, and it was carried out, or the City, at this moment, might have been without the London and Metropolitan Railway. Assistance was also got in other quarters. The question was now raised whether they should be permitted to disturb some roadway for the purpose of making an important City station. As to the suggestion that the tubes should be at least 10 feet under the London clay, from his experience of 30 years, he could say that the existing railways could not have been constructed, nor could the underground railway which Mr. Barry was carrying out in Glasgow, if that general principle was to be laid down. If this was to be a condition, then the most kind thing would be to put these directors out of their misery at once by rejecting the Bill. It would be absolutely impossible to carry out the lines if such conditions were imposed. It was because of a slight accident in the case of the South London Railway, when some of the gravel fell through into the tunnel, that this suggestion was made. That could easily be prevented by means of the present appliances—a shield costing less than £20. It was an insult to the engineering profession in this country to say that the railway could not be made without going down into the clay. A railway through the gravel was now being made at Baltimore, U.S. Sir Benjamin continued—The Metropolitan Railway was not designed to carry ordinary rolling stock, and they never have. They have special locomotives and special carriages. The round tops to the doors were made to fit the tunnels. If you have to build special rolling stock, you may as well have the ordinary Pullman type. With carriages of this type you would have shorter stoppages—stoppages of 10 seconds, instead of the long stoppages now seen. The New York elevated roads carry a great many more passengers than the underground lines in London. For convenience and comfort I prefer the overhead to the underground lines; but if it were proposed in London, the County Council would have something very serious to say against it I am afraid. These 10-feet and 12-feet tubes have been authorised by Parliament ever since 1865. They are quite able to carry as many passengers as the ordinary railway. The experiments were successfully made in 1865. Engineers have always been of the opinion that if you make many railways beneath London, they must consist of tubes of this small diameter. Since 1865, engineers have fully recognised the fact that these tubes are sufficient. The two tubes of the Central London line would carry 360,000 people per day, if necessary. Another reason why the underground railways had not hitherto been carried out is that there was no suitable tractive force till electricity and cables were brought into use. I am not in favour of junctions with the ordinary lines. They could not be used if made. As to the size of the tubes, 11 feet 6 inches should be the minimum. Everything is ripe now for the expansion of these railways—if we act in harmony with the local authorities. Unless the needs of the traffic are met in this way, new streets will have to be made in the congested parts to relieve the pressure, and the cost of that would fall on the people. What harm would there be in having a stairway to carry people off at once instead of sending them through the streets? The Corporation have made underground lavatories at different points for the public convenience, and what would be done by us in this case would be similar. The District Railway does not pay because of the want of sympathetic action on the part of the public bodies. It is not the case that three of the stations are to be in that narrow space opposite the Mansion House. If any important value be attached to the subsoil it would materially interfere with the success of these schemes. It might, under certain circumstances, be wise to make a public subvention in favour of these lines. The cost of making the lines would be much more costly than that of making ordinary railways, which pay nothing when crossing public roads, though they pay for going over private land. The cast iron tube is a great security to property, and there would be very little public inconvenience in the carting away of the soil.

Mr. BOLTON: Don't you think that the companies could give the public some substantial return for the privilege of being able to get a free permanent way—something in the way of cheap trains, say.

WITNESS: Yes, that would be fair, and it is right in principle.

The CITY REMEMBRANCER called attention to the inconvenience that would follow if the entrances to the subways were made so as to impede the flow of the pedestrian traffic. It would be advisable to have the entrances away from the main lines of traffic.

Sir B. BAKER said the people would trickle down beneath the surface and be absorbed by the underground lines, instead of being sent on into the different streets. It is an affront to the engineering profession to say that the railways should be in the London clay, it being quite as easy, with modern appliances, to burrow in the gravel. It was a monstrous proposition to say that the lines must be deep down in the clay. There will be no appreciable vibration from the lines—not nearly so much as from existing traffic.

The REMEMBRANCER showed that it was forbidden to construct vault, arch, or cellar under the street without the consent of the Commissioners of Sewers previously obtained. If a man had a house on each side of the street, and the two houses faced each other, he might be allowed to connect them by means of a tunnel beneath the sewers.

Sir JOHN FOWLER said suggestions had been made to the committee which seemed to him so extremely objectionable, that he was anxious—having the right to speak from long experience—to give his opinions. One suggestion was that lines should be made so that the ordinary railways could use them.

The CHAIRMAN: I may almost say you need not mention that; the committee do not approve of it.

Sir JOHN FOWLER: It is so obvious that it is impracticable, that I need not say any more. As to the depth of the tunnel. To say that it must be in the London clay would make the thing impossible, but there should be some restriction as to depth. It always is, and should be done. In the original Metropolitan Act, I obtained power to go down to any depth, but was restricted as to nearness to the surface. It seems to me idle to say that junctions should be made, but each line should be dealt with on its own merits.

Mr. Alderman R. M. BEACHCROFT, member of the London County Council, said that lines should be continued into the country to relieve the congestion in the traffic. He was authorised to press this on behalf of the County Council. People displaced in any clearance scheme seldom found their way back to the buildings erected for them. If the law as regards overcrowding were enforced in London, 500,000 people would have to be displaced, and the council thought any new railway companies should be placed under terms to give facilities for the passage of the working classes out of London to the suburbs. The only one of the present lines that seemed to do this was the Great Northern extension. There was ample evidence that the cheap trains to the suburbs were remunerative, as was shown by the building outside. While the density of population was increasing in the central districts, it was much increasing on the border of the metropolis; that arose from the natural growth of the population outwards, and from the increased travelling facilities given by the railway and other companies. Witness gave statistics to illustrate the extension of population to the outside of London.

The CHAIRMAN said witness might feel satisfied that the committee saw the importance of increasing the facilities for travel in and out of London. They wished to deal rather with the particular schemes.

WITNESS: The County Council are of opinion that the lines should not be confined to the City, but should run out into the suburbs to meet the convenience of workmen and others. The present workmen's trains early in the morning are already very much overcrowded, and there ought to be an extension of the system. The lines might be run out into the open country at the outskirts.

Mr. WHITMORE: But who would take shares in lines run out into the open? (Laughter.)

WITNESS: Stations would not be made at first where the traffic did not warrant it. We think that if a profitable monopoly be handed to a company, the company should be made to act for the public interest, and not only for the convenience of getting about from one part of London to another, but of getting out of London altogether. It may be necessary at some future time to give subsidies to railways of the kind that are needed. I am not in favour of the throwing out of these Bills, but wish to alter them a little. I favour the whole of these lines, but would favour them still more if they were extended. Unless you put them under terms, they may not extend them. The population follows the line, and congestion might be caused at Hampstead, or other places, if the extensions are not made. I am not in favour of junctions with the main lines.

This concluded the evidence.

The joint committee of Lords and Commons held a private meeting on Monday last, and have adopted the following report:—

"1. The committee have met and have considered the matters referred to them, and have taken evidence submitted to them by the promoters of the various schemes, including that of electric and other engineers, as well as that of representatives of the London County Council, of the Corporation of the City of London, of the agent and surveyor of Lord Portman's St. Marylebone estate, and of the Board of Trade.

"2. The railway schemes that have been referred for their consideration are the following, viz.:—The Great Northern and City Railway, the Central London Railway, the City and South London Railway, the Waterloo and City Railway, the Baker Street and Waterloo Railway, and the Hampstead, St. Pancras and Charing Cross Railways.

"3. The committee desire, in their report, to deal separately with the proposed Great Northern and City Railway.

"4. The main objects of this scheme would appear to be to assist and relieve the great and growing local passenger traffic of the Great Northern line, and to afford it a new and direct access to the city.

"5. It appears to the committee that there can be no reason why this scheme should not be considered by committees in ordinary course.

"6. Further, the committee are convinced that direct communication through London for the main railway lines north and south of the Thames, whether for the convenience of their country or their suburban passenger traffic, would be of undeniable utility. And they cannot doubt that the growing needs of those lines will, sooner or later, lead to the construction of one or more of such communications.

"7. But the purposes which the proposed new lines, with the exception of the Great Northern and City railway, appear intended and adapted to meet are of a different character.

"8. They are required to relieve the overgrown passenger traffic along the chief thoroughfares, to provide for the natural expansion of London, and to check the congestion of our metropolitan population by facilitating cheap communication outwards to a circumference which tends constantly to recede.

"9. More such lines of communication are required with existing suburbs; and there is growing need of their extension still further into the country, in order to meet the increasing necessity for the removal of portions of the population to a greater distance

"10. The lines now in question will afford some portion of this much-needed accommodation; and where they terminate in or near the open country they are practically certain of further extension to meet the needs of a growing and spreading population.

"11. It does not appear to the committee, with regard to any of these lines, that their construction would prevent that of other lines which the necessities of London may from time to time require, and they see no reason, therefore, for advising the postponement of the consideration, in ordinary course, of any of these Bills.

"12. With regard to the question whether underground railways worked by electricity or cable traction are calculated to afford sufficient accommodation for the present and future probable traffic, the committee report that the evidence submitted to them was conclusively in favour of the sufficiency and the special adaptability of electricity as a motive power for the proposed underground tubular railways, whilst the method of cable traction appears also to be of recognised utility, especially in the case of steep gradient lines.

"13. The proposed routes appear to be fairly satisfactory, considered as an instalment of the more complete accommodation necessary to meet the constantly increasing needs of London.

"14. As to the terms and conditions under which the subsoil should be appropriated, the committee report that in the case of private property not under the public streets, it appears to them to be desirable that the companies should be allowed to acquire a wayleave, instead of purchasing the freehold of the land, subject to the terms of the Lands Clauses Acts as to compensation.

"15. In the case of public streets the committee think it expedient that the companies should be empowered to pass under the streets at sufficient depth without payment of compensation for the wayleave. In consideration of such free passage the committee advise that the companies should be put under obligation to furnish an adequate number of cheap and convenient trains.

"16. The evidence submitted to the committee on the question of the diameter of the underground tubes containing the railways, has been distinctly in favour of a minimum diameter of 11 feet 6 inches."

The various Bills proposing electric underground railways have, by the Committee of Selection, been referred to a Committee of the House of Commons. The chairman is Sir John Kennaway, Bt., Mr. T. W. Sidebotham, Mr. E. Holden, and Mr. Esslemont. The first sitting of the Committee is to be held next Tuesday.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

"On the Cause of the Changes of Electromotive Force in Secondary Batteries," by J. H. Gladstone, Ph.D., F.R.S., Member, and Walter Hibbert, F.I.C., Associate, read on Thursday, May 12th, 1892.

In 1882, Dr. Gladstone and the late Mr. Tribe sent to *Nature* four letters on the "Chemistry of Secondary Batteries." The main point established in these papers was the all-important functions of sulphate of lead. They showed, in fact, that when a lead lead-peroxide cell is discharged, "sulphate of lead is the ultimate product on both plates; and when it is charged again, this lead sulphate is oxidated on the one plate, and reduced on the other."

In 1883, another letter appeared, in which, among other things, the effect of different strengths of acid when the cell is being charged was investigated, and the existence of occluded hydrogen, ozone, and hydrogen dioxide was considered.

These letters were subsequently published in book form.* In a paper of the same authors in the *Journal of the Chemical Society* for 1883, p. 345, reference was made to the production of persulphuric acid in the electrolysis of oil of vitriol.

In 1883, Professor Frankland† obtained substantially the same results, and proposed to ascertain the state of a cell during charge or discharge by observing the density of the acid.

In 1889, Messrs. Duncan and Wiegand‡ investigated the rate of diffusion of the acid out of the pores of the spongy masses in the plates of a secondary battery.

In 1889, Heim§ investigated the change in capacity of secondary batteries when used with different strengths of acid, and gave the E.M.Fs. observed when the strength varied from 10 to 35 per cent. H_2SO_4.

In 1890, we published experiments‖ which led us to regard the "abnormal initial E.M.F. of a secondary battery as due to inequality of acid strength, and its gradual disappearance as due to equalisation of strength produced by diffusion."

Shortly after this, an elaborate and valuable series of observations on accumulators was published by Messrs. Ayrton, Lamb, Smith, and Woods¶, who have given curves showing the changes in potential difference under many conditions of working. They allude to our suggestion, and conclude on various grounds that it is insufficient to explain some of the phenomena.

In the discussion which followed this paper, Mr. Hibbert urged that curves given by the authors afforded confirmation of our hypothesis.

Subsequently, two papers were sent to the Royal Society by Mr. G. H. Robertson and Professor Armstrong,** of which only the abstracts have been printed. From these, as well as from a lecture by Mr. Robertson at the Society of Arts,* we gather that they attribute much to the formation of persulphuric acid and hydrogen dioxide.

We have lately been making additional experiments on the matter, which have led us to the conclusion that *variations in the strength of the sulphuric acid are the main cause of the variations in electromotive force.*

We propose to consider—

1st. What variations of strength of acid actually occur during charge, repose, and discharge.

2nd. Experimental determination of the change of E.M.F. produced by changing the strength of acid.

3rd. How far this is capable of explaining all that is known about the changes of E.M.F.

4th. Confirmations, experimental and theoretical.

5th. Other suggested causes.

Part I.—What Variations of Strength of Acid actually Occur during Charge, Repose, and Discharge.

(*a.*) *Changes during Charge.*—If we start with a properly formed cell which has been discharged, we have to deal with two leaden supports, on one of which there is a mixture of lead sulphate, $PbSO_4$, with more or less peroxide, PbO_2, and on the other a mixture of lead sulphate, $PbSO_4$, with more or less spongy metallic lead. Each of these mixtures is a porous layer the interstices of which may penetrate to the leaden support.

To avoid confusion, we propose describing the one as the Pb O plate, and the other as the Pb plate.

If these be charged, the chemical action consists of the conversion of the lead sulphate on the one plate into PbO_2, and on the other into spongy lead, and the electrolytic change may be expressed thus:—

$$PbSO_4 + H_2O \ldots\ldots H_2O + PbSO_4 = PbO_2 + H_2SO_4 \ldots\ldots H_2SO_4 + Pb.$$

It is evident that during this process sulphuric acid is formed in the pores of both plates, whilst at the same time an equivalent amount of water disappears.

Apart from this electro-chemical result, which is equal on both sides, it is well known that during an electrolytic decomposition there is a gradual heaping up of the acid at what is now called the positive electrode, and a drawing of it away from the other. This increase of strength of acid at the peroxide plate may be seen by the descent of a denser layer of acid through the clear space under the plate. Indeed, it is well known that there is a circulation in the cell, the acid becoming stronger at the bottom and weaker at the top.

But to remove any doubt as to the strength of acid in the pores of the peroxide being greater than in those of the other plate, we made a direct experiment.

A cell was made of two small fully formed plates, each in a porous pot containing about 30 cubic centimetres of acid. These porous pots were placed in a large dish of the same acid and a current of 0·2 ampère sent through for two hours. After that time, the acid in the pot containing the PbO_2 plate had increased 3 per cent., whilst that round th Pb plate had diminished 1 per cent.

Of course, during the whole process of charging, diffusion is tending to equalise the strength of the acid, but it is much impeded by the capillary nature of the passages through which it must take place. It is quite conceivable that towards the end of charging, a film of the strongest acid—that is, H_2SO_4 itself—covers the working surface of the PbO_2 plate.

All these actions account for the well-known fact that during the charge the whole body of the liquid in a working cell rises in density by somewhere about 0·04.

(*b.*) *Changes on Repose.*—At the end of charging, the PbO_2 plate consists of porous peroxide attached to the lead support, surrounded by strong sulphuric acid. This sulphuric acid will diffuse out into the intermediate liquid at a rate which Messrs. Duncan & Wiegand's results show to be rapid at first. Complete equalisation is, however, a very slow process, to be reckoned by hours rather than by minutes.

But there are other actions reducing the sulphuric acid in the pores at the same time. The PbO_2 and its supporting lead are in a condition to set up energetic local action with the formation of sulphate of lead, and consequent absorption of sulphuric acid from the liquid. The chemical change is as follows:—

$$PbO_2 + H_2SO_4 \ldots H_2SO_4 + Pb = PbSO_4 + H_2O \ldots H_2O + PbSO_4.$$

(It must be remembered that the Pb in this equation is the lead support for the peroxide. Common experience shows that it is corroded during use.)

This action clearly will absorb sulphuric acid from the liquid in the pores and replace it by water.

In a well-charged plate, there is always at first an evolution of a little oxygen gas, which has been attributed† to the reaction of hydrogen dioxide on peroxide of lead.

$$PbO_2 + H_2O_2 = PbO + H_2O + O_2.$$

If this be the case, the oxide of lead (Pb O) formed must also abstract its equivalent of sulphuric acid from the liquid.

Of the three causes of weakening—diffusion, local action, and reduction by H_2O_2—the first goes on till the acid in the pores is brought down to the same strength as that in the intermediate liquid. But the local action may still continue for many days, and will tend to keep the acid in the pores a little weaker than that in the external liquid, notwithstanding the return diffusion of acid towards the plate.

Turning now to the Pb plate in repose, we find none of the above

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* "The Chemistry of Secondary batteries." Macmillan, 1883.
† *Proc. Roy. Soc.*, Vol. xxxv., p. 67.
‡ *Electrical World*, June 15th, 1889.
§ *El. Zeit.*, 1889, p. 88.
‖ "Notes on Secondary Batteries," *Phil. Mag.*, 1890, p. 168.
¶ *Jour. Inst. Elec. Engineers*, 1890, pp. 539 and 660.
** *Proc. Roy. Soc.*, 1891, pp. 105 and 108.

* *Soc. Arts Journal*, Dec. 4, 1891.
† "Chemistry of Secondary Batteries," p. 51.

actions taking place, except the slow equalisation of strength produced by diffusion.

But there is an action peculiar to this plate—that is, a direct, slow chemical action of the sulphuric acid on the lead, producing lead sulphate and hydrogen gas.* The equation is

$$Pb + H_2SO_4 = PbSO_4 + H_2.$$

This must gradually produce a weakening of the acid in the pores, and it is important to notice that diffusion, which is always slow, will be almost entirely prevented by the choking up of the capillary passages by the gas evolved.

We have indicated the probability that towards the end of a charge there is a film of the strongest acid against the working surface of the PbO_2 plate. If this be true, it is evident that as soon as repose begins, such a film will almost immediately disappear, owing to diffusion into adjacent liquid, whether in the pores or out of them.

(*c.*) *Changes during Discharge.*—As soon as the discharge begins, a still more rapid reduction of the strength of acid may be expected. Diffusion, local action, and reduction by H_2O_2 will still take place on the PbO_2 plate, and the direct chemical action on the Pb plate, but on each plate there is superadded the ordinary discharge reaction of the cell. The form of the equation for discharge is the same as that already given for local action, namely—

$$PbO_2 + H_2SO_4 \ldots H_2SO_4 + Pb = PbSO_4 + H_2O \ldots H_2O + PbSO_4.$$

(In this case the Pb represents spongy lead on the Pb plate.)

But while the absorption of sulphuric acid and production of water thus goes on in both plates, electrical transference of the H_2SO_4 now takes place from the PbO_2 to the Pb plate, causing an additional weakening of the acid in the pores of the first.

If discharge has commenced immediately upon the cessation of charging, these different causes will combine to produce a very rapid decrease in the strength of the acid at the PbO_2 plate.

In any case, a period must soon arise in which the great excess of sulphuric acid originally about the PbO_2 plate has disappeared through these various agencies, and the acid on both plates will be reduced to pretty nearly the same strength as that of the intermediate liquid. After this, there will be a gradual withdrawal of acid from the liquid in the pores, more or less compensated by diffusion inwards from the intermediate liquid. This, of course, brings about the reduction in the strength of the whole acid, which is well known to take place during discharge.

The strength of the acid in the pores will be determined by the relative values of the rate of withdrawal and the rate of diffusion. But while the rate of withdrawal continues constant for a given discharge current, the rate of diffusion rapidly diminishes.† The rate of weakening of the acid is therefore a constantly increasing one, and may finally become so rapid that the acid strength of the liquid against the working surfaces of the plates is very low or almost *nil*.

In such a case we may expect the formation of the white compound described by Gladstone and Tribe,‡ which when analysed seemed to be a basic compound of the composition $2PbSO_4 . PbO$.

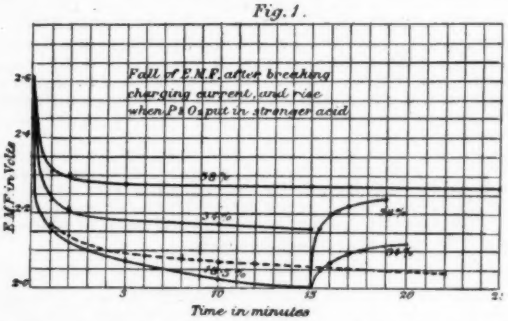
(*d.*) *Changes on Repose after Prolonged Discharge.*—If through prolonged discharge the acid against the working surfaces has become very weak, and the discharge is then stopped, it is evident that the acid in the pores will quickly increase in density, and uniformity of strength in and outside the pores will be restored after awhile; but the general strength will always be lower than the original value. A renewal of the discharge will, however, soon lead to exhaustion of the acid against the working surfaces.

PART II.—EXPERIMENTAL DETERMINATION OF THE CHANGE OF ELECTROMOTIVE FORCE PRODUCED BY CHANGING THE STRENGTH OF ACID.

It is a matter of general knowledge that the electromotive force of an accumulator rises slightly when the strength of the acid is increased. Incidental determinations of the rise occur in several papers, of which we may mention one by Preece§ and another by Heim.‖

In 1890, thinking it probable that the chief cause of the high E.M.F. was "the great inequality in strength of acid produced by the charging current," we made some experiments which were described, with tabulated results, before the Physical Society.¶ Instead of repeating these, we now throw the results into a diagram of curves (fig. 1).

Fig. 1.



For each case, the ordinates represent E.M.F. of the cell in volts, the abscissæ represent time in minutes. The figures attached to the curves show the percentage strength of the acid round the PbO_2 plate. The Pb plate was always in 18·5 per cent. acid.

The curves show: First, that in each experiment the E.M.F. at the commencement of discharge is about the same value, 2·58 or 2·6.

Secondly: That the fall after stopping the charging current was initially more rapid in the case of the weaker acid. The subsequent and more permanent E.M.F. also depends on the strength of the acid, the value for 58 per cent. acid being 2·27 volts; for 34 per cent. acid, about 2·15 volts; for 18·5 per cent. acid, about 2·01 volts. When the cell has been in repose 15 minutes, the weakest acid gave 0·26 volt less than the strongest, and 0·14 volt less than the 34 per cent. acid.

Thirdly: That if, when the E.M.F. has fallen, the strength of the acid be increased, the E.M.F. quickly rises, and, as the acid soaks into the pores, eventually attains about the same value as if that particular strength of acid had been maintained throughout.

This seemed to justify our conclusion, but we were desirous of obtaining more direct evidence of the effect of varying strength of acid. In our old experiments we measured E.M.F. by the condenser method, and have again found it useful in many experiments. But we have now made more accurate determinations by the potentiometer, and in one series of experiments by observing the current obtained through a high resistance.

Throughout the new experiments we have employed the same two plates. The supports consisted of thick lead wire doubled on itself. These were pasted with red lead and then "formed" in the usual way, until the paste on one was pure lead, and on the other pure peroxide of lead. The active part of each was about three inches long and half an inch diameter. The containing vessel and acid varied according to requirement, as described below for the particular experiments.

We found that on transferring the plates from a weaker to a stronger acid the E.M.F. begins to go up, at first rapidly, afterwards more and more slowly. But the final value is not reached for some hours. It was impossible to allow so much time for each observation, and in our earlier experiments we made our determination of E.M.F. at the end of 20 minutes or so. Consequently in these our figures do not represent the ultimate value of the E.M.F. for that strength of acid, but they do not fall much short of it.

In all experiments the plates were fully charged, and before being used were washed free from the liquid products of electrolysis.

1st Series.

In the first series both plates were immersed in acids of the same strength. When one observation had been made, the plates were quickly transferred to another cell containing stronger acid, and the E.M.F. occasionally tested for 15 minutes, when it was finally observed, and the plates again removed into a cell containing still stronger acid, and so on. The following table gives the results:—

TABLE I.

Acid in Cell round both Plates.		E.M.F. of Cell in Volts.
Density.	Percentage Strength.	
1·045	6·5	1·887
1·065	9·5	1·898
1·080	11·5	1·915
1·115	16·2	1·943
1·157	21·7	1·978
1·217	29·2	2·048
1·254	33·7	2·088
1·335	43·0	2·170

The last acid was found to act vigorously on the spongy lead, so that this series was discontinued.

2nd Series.

The same procedure was followed, with the exception that the Pb plate was kept throughout in acid of density 1·098 = 14 per cent. The peroxide was transferred from one to another of a series of porous pots filled with acids of the strength given below:—

TABLE II.

Acid round PbO_2 plate.		E.M.F. in volts.
Density.	Percentage strength.	
1·045	6·5	1·926
1·065	9·5	1·932
1·080	11·5	1·939
1·115	16·2	1·949
1·157	21·7	1·963
1·217	29·2	1·986
1·254	33·7	2·013
1·335	43·0	2·061
1·53*	63·0	2·22
1·75*	81·0	2·33

* The two last observations really belong to another set of experiments, where the acid round the lead = 23 per cent.

* Gladstone and Hibbert, *Phil. Mag.*, 1890, p. 164; Ayrton and others, *Jour. Inst. Elec. Engineers*, 1890, p. 680.

† This might be expected from the partial clogging of the pores by the $PbSO_4$ formed on both plates, and it has been experimentally shown to be the case by Messrs. Duncan and Wiegand.

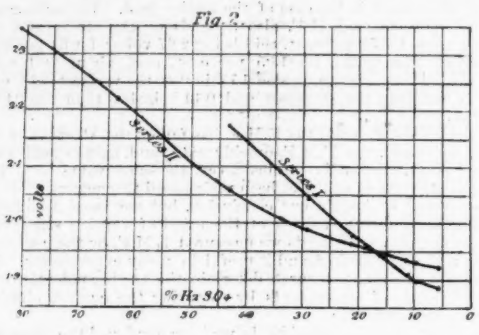
‡ "Chem. of Sec. Batts.," p. 46. ‖ *El. Zeit.*, 1889, p. 88.

§ *Proc. Roy. Soc.*, 1883, p. 460. ¶ *Phil. Mag.*, 1890, p. 168.

The results of the two series are plotted in the diagram (fig. 2).

It will be seen—First, that in both cases the E.M.F. increases with the strength of the acid, although in Curve II. there is no change in the acid at the Pb plate; secondly, there is no coincidence of the curves except where the conditions of the experiments are practically identical; thirdly, that for any given abscissa the E.M.F. in Curve I.

Fig. 2.



is smaller than that in Curve II. when the acid about the Pb plate is less than 14 per cent., and greater when it is more. Hence it follows that the E.M.F. depends on the strength of the acid at both electrodes.

3rd Series.

Not being satisfied with the range or the accuracy of the preceding series, we endeavoured to obtain a curve representing the relation between E.M.F. and strength of acid within the widest limits.

After preliminary trials and considerations, we adopted the following plan. The experiments were divided into two parts, in consequence of the action of strong acid on spongy lead.

In the first part, we commenced with an acid of 5·6 per cent., and worked upwards to 49 per cent., allowing the plates to stand half an hour in each acid before final observation of E.M.F. The process was then reversed, working downwards through the same acids to 5·6 per cent. again, and then continued through weaker acids to a mere trace—less than 0·05 per cent.—and the cycle finished by returning once more to 5·6 per cent. As even half an hour or an hour is scarcely sufficient for equalisation of the strength of the acid within and without the pores of the plates, it may be expected that the ascending series would scarcely represent the full effect of the rise, whilst the descending series would scarcely represent the full effect of the fall. We therefore give in Table III., not only the numbers actually obtained, but also the means of the ascending and descending series, which cannot be far from the true values. We have proof of this in the case of the 5·6 per cent. acid, where the mean is 1·89 volts, while the true E.M.F., as very carefully determined previously for the same strength, was 1·88 volts. This agreement also proves that no appreciable change had come over the plates during the operations.

TABLE III.

Time of Soaking.	Density of Acid.	% H_2SO_4.	Electromotive Force in Volts.		
			Ascending.	Descending.	Mean.
1 hour	... ...	Trace	... ...	1·507	1·507
,,	1·008	1·2	1·747	1·777	1·762
,,	1·013	2·0	1·792	1·825	1·808
,,	1·020	3·1	1·835	1·867	1·851
,,	1·037	5·6	1·875	1 908	1·891
30 minutes	1·071	10·4	1·922	1·953	1 937
,,	1·154	21·3	1·993	2·016	2·004
,,	1·233	31·2	2·055	2·066	2·060
15 minutes	1·388	49·0	2·149	... ...	2·149

In the second part of the experiments of this series, the Pb plate stood throughout in 27 per cent. acid. We commenced with the Pb O_2 plate in 43·5 per cent. acid, ascended to 88·5 per cent., and then returned to 43·5 again. A longer time was here allowed for diffusion, as the strong acid is very viscid. Notwithstanding this longer soaking, the differences between the ascending and descending series are greater than before. The results are given in the following table:—

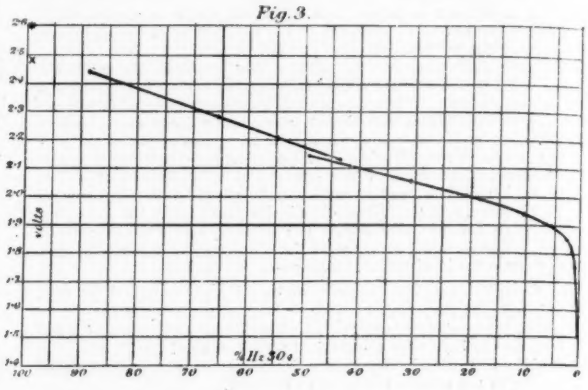
TABLE IV.

Time of Soaking Peroxide Plate.	Acid round Peroxide.		E.M.F.		
	Density.	% H_2SO_4.	Ascending.	Descending.	Mean.
50 minutes	1·338	43·5	2·106	2·163	2·135
50 ,,	1·446	54·8	2·179	2·233	2·203
50 ,,	1·569	66·0	2·259	2·298	2·277
60 ,,	1·605	69·0	2·279	2·342	2·310
60 ,,	1·723	79·0	2·354	2·398	2·376
60 ,,	1·814	88·5	2·442	...	2·442

The mean results of Tables III. and IV. are given in the diagram (fig. 3).

The two curves very nearly join, and when it is considered that the highest E.M.F. of the lower curve is almost certainly too low, and the lowest E.M.F. of the upper curve too high, the coincidence is striking.

Fig. 3.



An attempt was made to get an observation in very strong acid. The fully charged Pb O_2 plate was washed in water, and dried at 100° C. It was then soaked in 95 per cent. acid. After 34 minutes' soaking, the E.M.F. was observed, and the plate then placed in weaker acid. In consequence of absorption of water from the adjacent liquid of the cell, as well as from the atmosphere, the acid round the Pb O_2 plate fell to 91·5 per cent., the Pb plate standing all through in 27·5 per cent. acid. Results are given below, and are fairly confirmatory of the previous figures:—

TABLE V.

Time of Soaking.	Acid round Pb O_2 Plate.	E.M.F.
34 minutes	91·5 per cent.	2·44
63 ,,	77·5 ,,	2·37
67 ,,	65·5 ,,	2·28
97 ,,	53·0 ,,	2·16

The highest E.M.F. here obtained (2·44) is very nearly the same as that given in Table IV. for 88 per cent. acid.

A still further effort was made to get an observation in the strongest acid. A Pb O_2 plate was soaked all night in 80 per cent. acid, and in the morning transferred to a jar containing 99 per cent. H_2SO_4. This was kept under a closed bell jar for 4 hours, after which the E.M.F. between the Pb O_2 in this strong acid and a Pb plate in 25 per cent. acid was measured by potentiometer. The value was 2·47 volts, which, after 30 minutes further standing, rose to 2·48 volts nearly. This is represented in fig. 3 by X.

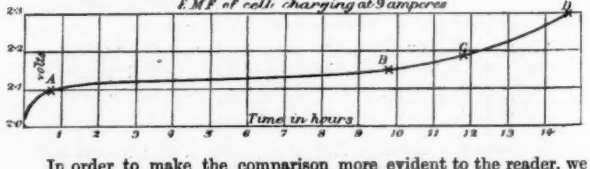
It was expected that a still higher voltage could be obtained if both plates were immersed in the strongest acid, undiluted H_2SO_4. The difficulty was that this acid acts pretty readily on the spongy coating of the ordinary Pb plate, so we made an experiment with a strip of ordinary clean sheet lead. Placing this in the same H_2SO_4 in which the Pb O_2 plate had been standing for some hours, the E.M.F. was found to be as high as 2,607 * volts. This is indicated in fig. 3 by *.

PART III.—HOW FAR ARE THESE RESULTS CAPABLE OF EXPLAINING ALL THAT IS KNOWN ABOUT CHANGES OF ELECTROMOTIVE FORCE?

At the very beginning, it is evident that the experiments described in Part II. more than cover the range of variation in E.M.F. during ordinary work. For these limits are: a maximum P.D. of 2·5 volts at the end of a charge, and 1·8 volts at the end of a discharge—figures which come within the variations produced by strong and weak acid.

But our results go much farther than this; and for the purpose of detailed consideration we shall compare them (as shown in Parts I. and II.) with the valuable observations of Prof. Ayrton and his collaborateurs. Their papers in the journal of the Institute† contain the most elaborate and trustworthy account of working variations of P.D. which has yet been published.

Fig. 4.



In order to make the comparison more evident to the reader, we give the two following time curves of E.M.F. in charge and discharge.

* The same E.M.F. was obtained whether the lead was cleaned by scraping with a knife, or by washing with acetic acid.

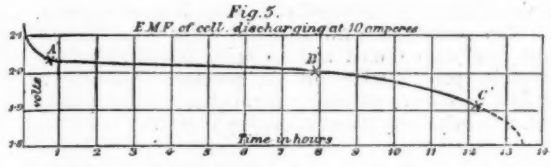
† Loc. cit., pp. 661, 545.

They are deduced from the curves of P.D. values given by Prof. Ayrton and others in the figures opposite p. 661, by making allowance for the resistance as exhibited on pp. 590 and 592. We indicate for certain marked points in the curves the percentage strength of the acid in the general body of the cell, as deduced from the specific gravities given on pp. 672 and 673 (figs. 4 and 5).

ACID IN GENERAL BODY OF CELL DURING CHARGE.

At Point	Density given.	% $H_2 SO_4$.
A	1·178	24·5
B	1·198	27·0
C	1·201	27·4
D	1·206	28·0

Fig. 5.



ACID IN GENERAL BODY OF CELL DURING DISCHARGE.

At Point.	Density given.	% $H_2 SO_4$.
A′	1·205	27·8
B′	1·189	25·9
C′	1·180	24·8

As far as charging is concerned, we have already shown that sulphuric acid must be continuously formed by the decomposition of the sulphate on each plate, and that the acid must become more and more concentrated, especially against the $Pb O_2$ plate. If our views be correct, this must give rise to an immediate rapid increase of E.M.F.; but as the action proceeds, the tendency of the heavy acid to sink towards the bottom of the vessel, or to diffuse into the weaker intermediate acid, will become greater, and a point will be reached when the production of sulphuric acid against the plate will be nearly counter-balanced by its dispersal. The E.M.F. will still rise slowly, because the intermediate acid is gradually increasing in strength.

(To be continued.)

LONDON COUNTY COUNCIL.

AT the meeting held on May 10th, the following report of the Parliamentary Committee was presented:—

Electric and cable railways.

A joint committee of Lords and Commons, having been appointed to consider the best method of dealing with electric and cable railway schemes, we have considered the question of the evidence to be adduced on the part of the council before the committee. We have had before us, in connection with the subject, reports by the Parliamentary agent and the chief engineer, and have directed our attention to the third report of the Select Committee of the House of Lords, 1863, and the report of the Joint Committee of the Houses of Lords and Commons, 1864, on Metropolitan railway communication. In our report to the council on the 9th of February last, especial reference is made to underground communications, and suggestions are contained in that report which we have adopted, and decided to include in our proposals as to the line of evidence to be taken before the Joint Committee. Having given the whole subject our most careful consideration, we propose to submit to the Joint Committee the following propositions as indicating the position which the council will take in the coming enquiry—

(1) That the size of the tunnels of the lines should be sufficient to allow in the future of an interchange of traffic with existing railway lines.

(2) That, subject to the other conditions and to any geological or other unforeseen difficulties which may be met with, underground lines should not follow the line of existing streets, but should go from point to point, the depth below the surface being such as to avoid injury or inconvenience to buildings in the line of the railways.

(3) That the companies should only be allowed to acquire the right of forming the tunnels without acquiring any absolute freehold in the soil, paying compensation for actual damage only.

We are of opinion that the traffic capable of being accommodated by a railway of the class proposed between the north and south of London is not of so large an extent as to justify more than one railway. It would be at present impossible to obtain the necessary capital for the construction of more than one, as it would be obvious that, if the traffic were divided between two lines, the expenditure on each must be unremunerative. We therefore think that the formation of more than one such line should not be encouraged.

In the Central London Railway Act, 1891, valuable provisions were inserted at the instance of the council, which we think should also form part of any new Acts authorising further underground communication. We have given the agent the necessary instructions to take steps for submitting the views above set out to the consideration of the joint committee.

Another point to which we have directed our attention is the question of the desirability of urging on the joint committee the introduction in the Bills of clauses giving to the council compulsory powers of purchase of the undertakings. There is a precedent for this in the case of the tramways, and we are strongly of opinion that, in the public interest, it is desirable that such a power should be reserved to the council. Such undertakings are, in fact, in the nature of underground tramways; they are purely metropolitan, and are not railways in the sense of carrying passengers outside the metropolis. It appears, therefore, to us that the same principle may be adopted with them as with regard to tramways, with the addition of a concession that, in a matter which requires a longer time to develop than mere horse traction on the surface of the street would require, there should be a period allowed, not of 21 years, as in the case of tramways, but of 60 years, so as to enable those who find the capital in the first instance time to obtain remuneration for that capital.

We have accordingly framed, for the consideration of the joint committee, a clause on the model of section 43 of the Tramways Act, 1870, with the exception that a period of 60 has been substituted for 21 years. We propose that if the council, by resolution passed at a special meeting, so decide, it may, within six months after the expiration of a period of 60 years from the passing of an Act authorising such a scheme, and within six months after the expiration of every subsequent period of seven years, by notice in writing, require the company to sell, and thereupon the company shall sell to the council the undertaking, the terms of payment being the then value (exclusive of any allowance for past or future profits of the undertaking, or any compensation for compulsory sale or other consideration whatsoever) of the railway, and all lands, buildings, works, materials and plant of the company, suitable to and used by them for the purposes of their undertaking, such value to be, in case of difference, determined by an engineer or other fit person nominated as referee by the Board of Trade on the application of either party, and the expenses of the reference to be borne and paid as the referee may direct. And when any such sale has been made, all the rights, powers and authorities of the company, in respect to the undertaking sold, shall be transferred to and vested in, and may be exercised by the council in like manner, as if such railway had been constructed by the council under Parliamentary powers. We recommend (*a*) That the course taken by us in instructing the agent to submit these views to the joint committee be approved. (*b*) That the council do approve of powers being sought to enable the council eventually to acquire electric and cable railway undertakings, and do authorise the Parliamentary Committee to submit a clause on the lines indicated in the report, to the joint committee on the Bills.

Mr. SAUNDERS moved as an amendment "That the suggestion that only one such line should be constructed between North and South London be omitted, and that evidence be placed before the joint committee showing the importance of continuing into the country electric and cable lines, which may pass under London, in order to relieve the congestion of population, and encourage building in the suburbs, and that, subject to the above, the course taken of the Parliamentary Committee be approved."

Mr. BEECHCROFT seconded.

Mr. CHARLES HARRISON took no objection to the amendment, although he said it was not quite in order, because it proposed to take exception to a measure which was not one of the recommendations contained in the report, but as it would be inserted by way of an addition, there could be no objection to it.

After further discussion the amendment was agreed to, and the report of the committee as amended adopted.

REPORT OF THE HIGHWAYS COMMITTEE.

The following was submitted on May 17th:—

Electric lighting—Applications for Provisional Orders.

We have to report, for the council's information, that an intimation has been received from the Board of Trade that the amendments suggested in our report on May 3rd, have been made in clause 2 of the Shoreditch Electric Lighting Order, applied for by the Vestry of Shoreditch.

The Board has also intimated, with reference to the county of London (North) Electric Lighting Order, that, in accordance with the suggestion contained in the same report, the name of the council has been inserted in line 8 of clause 23, relative to revocation of the order, but that the Board considers that the other suggested amendment is unnecessary. We think the adoption of the amendment would have rendered the clause more clear; but we do not advise the council to press for its insertion.

The Board of Trade has forwarded for the council's observations, a copy of the North London (St. Luke, Middlesex), and of the South London (Newington) Electric Lighting Orders respectively, in the form in which the Board proposes to issue it. We have carefully examined these, which appear to us satisfactory; and we recommend that the Board of Trade be informed that the council approves of the form in which the Board proposes to issue the orders referred to.

Notices under Electric Lighting Acts and Orders.

We have considered a notice, dated April 30th, 1892, from the London Electric Supply Corporation, of intention to lay distributing mains, consisting of concentric lead-covered cables drawn into cast iron pipes, on the west side of Lewisham High Road from New Cross Road to the boundary of the parish of St. Paul, Deptford, and on the south side of the latter thoroughfare from Florence Road to Lawrie Grove, and thence along both sides of the road to the parish boundary, and crossing the thoroughfare at Queen's Road. There appears to be

no objection to the proposed works, which are similar to those of this company previously approved by the council, and we recommend that the sanction of the council be given to the works referred to in the notice dated April 30th, 1892, of the London Electric Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works, in the carrying out of which only one side of any thoroughfare shall be obstructed at one time; that the mains be laid under the footways, and be kept 9 inches below the underside of the paving wherever it is found practicable to do so; that where the mains cross the carriageways they be kept at the same depth below the concrete or the road material as the case may be; that no street boxes shall be constructed until the positions for, and the mode of construction of, them shall have been submitted to and approved by the council's chief engineer; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk of injury to the covering of the cables; that all cables crossing the boxes shall be supported from below in the boxes; that all service lines or small cables shall be protected, where leaving the boxes, by an extra lead covering or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable, in good connection with the lead or iron outer casing; and that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps, in addition to any other covering.

We have also considered a notice dated May 5th, 1892, from the House-to-House Electric Light Supply Company, of intention to lay mains from its central station in Richmond Road, across and along the north side of that road and of Old Brompton Road to Cranley Place. The proposed works are of the usual character, and we recommend that the sanction of the council be given to the works referred to in the notice dated May 5th, 1892, of the House-to-House Electric Light Supply Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works; that no pipes of a larger diameter than 6 inches shall be used; that the street boxes shall be of the pattern approved by the council, and that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable, and that the outer cover shall be efficiently connected to earth.

The Westminster Electric Supply Corporation has also given a notice, dated May 7th, 1892, of intention to lay mains, in 3-way Callender casing, in Barton Street and Cowley Street, Westminster. The works proposed are unobjectionable; and we recommend that the sanction of the council be given to the works referred to in the notice, dated May 7th, 1892, of the Westminster Electric Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works; that the street boxes shall be similar to those previously approved by the council, and that the covers thereof shall consist of iron frames filled in with material to suit the paving.

We have also to report the receipt of the undermentioned notices, given in accordance with the resolution of the council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid—

From the Electricity Supply Corporation: April 28th, 1892, to "Garrick" public house, Green Street.

From the St. James's and Pall Mall Electric Lighting Company: May 2nd, 1892, to 23, Cork Street; May 5th, 1892, to 41, Haymarket; 15, Savile Row.

From the London Electric Supply Corporation: May 3rd, 1892, to 36, Strand; May 4th, 1892, to 72A, and 78, High Street, Deptford; May 6th, 1892, to 9, Duke Street; 5, Deanery Street; 79, New Bond Street; May 10th, 1892, to Coutts's Bank, Strand.

From the House-to-House Electric Light Supply Company; May 3rd, 1892, to 30, Clareville Grove.

OBITUARY.

Peter William Willans.

It is our sad duty to announce the death of Mr. Willans, the well-known engineer. Mr. Willans, whilst driving on Monday last, from his house to Frimley Station, was thrown from his carriage and received injuries on the head which proved fatal. We believe that all members of the electrical engineering profession will acknowledge that Mr. Willans death may be considered almost a national calamity. As we pointed out some few months ago, his successes in producing high-speed economical steam engines have practically revolutionised the engineering of English central stations. Mr. Willans was not only widely known from the successful steam engine which bears his name, but he was also considered by many to be our leading authority on the question of steam engine economy. His paper on this subject, communicated to the Institution of Civil Engineers two years ago, has been received all over the world as a text-book on this important subject; in fact, the views that he expressed in that paper may be considered to have marked a new departure in steam engineering.

Mr. Willans served his time with Messrs. Eastons and Tattersall, of Leeds, and was afterwards in the works of John Penn and Sons, of Greenwich. He then invented the earlier form of his 3-cylinder high-speed engine, but it was not until he started his own works at Thames Ditton that this celebrated engine began to take its present form. The works at Thames Ditton were entirely laid out by Mr. Willans himself, and are considered by competent judges to be most admirably adapted for manufacturing steam engines on the interchangeable principle.

Of Mr. Willans's private character it is impossible to speak too highly. No man was more deservedly liked, and his death leaves a gap which it will be found very difficult to fill. Not a few of the leading electrical engineers owe a great deal, perhaps even more than they think, to the quiet advice and assistance rendered to them by Mr. Willans. Although he was considered to be a mechanical engineer, yet his close connection with electrical engineering during the past few years caused him to bring his singularly lucid reasoning powers to bear on the problems which, from day to day, have been presenting themselves to our profession, and in nearly every case with happy results.

REVIEW.

*Electrotechnical Instruction and Guide to the Management of Electrical Installations, especially on War-Ships.** *A Manual for non-commissioned Officers.* By M. Burstyn, Imperial and Royal Head Naval Engineer. With 214 illustrations in the text-pola: Carl Gerold's Son, 1892.

This work is a fairly comprehensive manual of electrotechnics, but with especial attention to the production and use of electric lights. Instructions are given both for the management of the arc lamp for illuminating objects outside the vessel, for search lights and especially for the detection of torpedoes. For giving light within a ship glow lamps are especially recommended. The most approved methods of signalling by night—Sellner's system—are also duly described. In a purely practical work like that before us we do not, of course, look for novelties, or for theoretical discussions. But we naturally expect, and accordingly find, clear, careful descriptions of the apparatus required for electric lighting on board ship.

NOTES.

Fires Caused by Electricity.—The daily press of the 21st instant gave prominence to the coroner's inquest relating to the fire at Scott's Restaurant, with especial reference to the evidence given by an electrical expert, and we observe that these accounts differ in most of the leading papers. The scientific witness is made to say in the *Times* what really, we believe, was said by the coroner, which makes all the difference; and it is greatly to be regretted that the evidence was not given *in extenso*, as we can hardly believe that it has been correctly reported. At the beginning of his examination Mr. E. C. de Segundo remarked that the ravages of the fire had destroyed all traces of the manner in which the wiring had been carried out; yet, at the end (after having given the jury the benefit of his doubts, and his suppositions as to what might have occurred) he came to the conclusion that it was probable that the fire was caused by a leakage in the electric wiring. Such statements naturally create in the minds of the public impressions unfavourable to electric lighting, as, indeed, it seems they caused an impression, fair from justified, in the minds of the coroner and jury, who are led to say that the danger of fire from the installation of the electric light appears to be greater than in the case of an escape of gas; and to further show how statements are often made upon mere hearsay we refer to the expert's remarks that he understood the building was insured in the Phœnix Fire Office, but was sure that their inspector would not have tolerated the position of

* Elektrotechnischer Unterricht und Anleitung zum Betrieb elektrischer Anlagon insbesondere auf Kriegsschiffen. Lehrbuch für Unterofficiere.

the wires had he known their proximity to the gas pipes. We are in a position to state on the best authority that only a very small part of the insurance was placed with the Phœnix Fire Office, and that only very recently; also the inspector for that office was never called upon to inspect, nor ever saw, this electric light installation. We have now sufficient data to go upon to prove conclusively the great safety of the electric light as regards fire risk. Here in England we have had but few instances of fires caused by electricity and are confident in asserting our conviction that this immunity from outbreak of fires will continue as long as work is done by contractors upon the now well-established rules, almost universally adopted in this country, of the Phœnix Fire Office or others based upon them. Nothing speaks more in their favour than the one fact, which has certainly not been disproved by the outbreak of the fire at Scott's, that not a single fire, so far as we are aware, has occurred in any of the buildings and houses which are now lighted by electricity, the wiring of which has been done according to these rules. It is unfortunate that the evidence given by an electrical engineer should be the means of disturbing the feeling of security which electric light has engendered in the minds of the English public, but it would be still more so if Mr. Segundo had not had the courage to state that the electric light is not absolutely infallible so far as fire risks are concerned. It is necessary not only to have rules, but it is imperative upon both supply companies and fire insurance people to see that they are rigorously enforced; this being carried out, everything which human ingenuity can at present devise has been done to secure immunity from fire.

The Electric Light in Germany.—Six of the principal streets in the town of Bayreuth are to be lighted electrically. The new docks at Magdeburg, Neustadt, are to be similarly illuminated. It is also intended to erect electric cranes.

The Best Frequency for Alternating Currents.—Asking this question is like putting the time honoured one about "the length of a piece of string." It all depends upon what we want, and how we intend to get it. Our esteemed contemporary, *Industries*, in its leading article for last week, gravely discusses this urgent point, and finally arrives at the conclusion that the American practice of 130 ∿ is perhaps the best. There is something better than the mere period question discussed, however, and that is the alternator of the future. *Industries* very properly condemns the old type "manifold dynamos," and looks hopefully forward to machines with single coils for field magnets and armatures, with periodicities limited only by the conditions of the work expected. The bearing of the frequency question in transformers is ably treated and the relatively high cost of low period transformers clearly shown. The alternating motor, *of the future of course*, is discussed in a few lines which disclose a *penchant* for cheap high speed machines suitable for high frequencies. We agree with our contemporary's opinion that a period of 25 ∿ would ruin both our pockets and our eyesight, and we confidently expect to find a rise in frequencies.

Obituary.—The *Journal of the Franklin Institute* announces the death of Mr. Eugene H. Cowles, at the early age of 38, which took place on April 21st, at El. Paso, Tex. He had attained a world-wide recognition by the scientific world for his inventions in connection with the manufacture of aluminium, in which he was assisted by his brother Albert H. Cowles. For their pioneer work and for the successful introduction of their process in America and in Europe, the brothers Cowles deserve the highest praise. The Franklin Institute was the first to recognise the importance of the inventions of the two brothers, who read a paper before the Institute on January 20th, 1886, on "The Production of Aluminium and its Alloys in the Electric Furnace." The highest honour of the Institute—the Elliott Cresson medal—was awarded to them in recognition of "their invention of a new process in the metallurgical arts for the reduction of refractory substances." They also obtained the John Scott Legacy Medal and premium for their electric smelting furnace. Mr. Cowles's untimely death before he had yet reached the measure of years when those better equipped with physical endowments are in the prime of their powers for usefulness, is a loss which all friends of science will learn with sincere regret.

Bell Telephone Company.—The *Financial News* states that it is proposed that the capital stock of the Bell Telephone Company of Canada shall be increased to $3,000,000, instead of $5,000,000, as proposed by the Bill now before the Senate.

Crystal Palace Exhibition.—At the meeting of the Crystal Palace exhibitors on Saturday last, on a vote being taken regarding the date for closing the exhibition, there were 75 in favour of closing on the earlier date, July 2nd, and 71 for remaining open until September 10th. The exhibition will therefore close on July 2nd. The directors of the Crystal Palace Company asked the exhibitors to do all in their power to create a boom and get a larger number of visitors for the next six weeks. Several exhibitors desired increased railway facilities to enable them to keep their stands open until eleven o'clock, and the Palace directors signified their intention of doing the best they possibly could in the matter.

Electric Lighting for Coventry.—The Electric Lighting Committee of the Coventry Council have decided to accept the offers of three firms to submit, free of charge, schemes and estimates for a central electric light station, on the terms that whatever scheme is adopted by the corporation, the execution of the work be let by public tender.

The Electric Light at Exeter.—At a meeting of the Council of the "ever faithful" city, last week, the surveyor's report on street lighting by electricity was considered. A tender had been obtained from the Electric Light Company, who agreed to supply the light for £22 10s. per lamp per annum, the Council providing lamps, posts, brackets and globes; or for £24 per lamp per annum if the company provided the lamps and globes. For the larger scheme proposed the annual cost would be £1,377 13s., against £724 11s. at present paid for gas; and for the smaller scheme £768, against £517 7s. 4d. The surveyor did not think the Council could look for a reduction in the price of electricity for some time to come. After a long discussion, in the course of which several propositions were made, the Council agreed to defer the further consideration of the surveyor's report until after an answer had been received from the Gas Company as to the improved supply of gas to the main streets of the city, and in the meantime the Electric Light Company to be asked to consider the hours of lighting.

London Chamber of Commerce.—The annual meeting of the Electrical Trade Section will be held to-day at 2.30 p.m. to consider the appended agenda, when a full attendance is particularly requested. Agenda:—1. Chairman's report as to the work of the section since its last annual meeting. 2. Election of chairman and deputy chairman for the ensuing year. 3. To consider the desirability or otherwise of the section following the precedent of other sections of the Chamber, in convening the whole of the membership of the section to all future meetings, appointing special committees to deal with special subjects. 4. The attitude of the electrical trade towards the Chicago Exhibition. 5. Telephone question. 6. The attitude of the section towards the Parliamentary committee, who are to consider the whole question of electric railways in London. 7. The action taken by the Chamber in reference to the question of overhead wires, and to consider the reply from the President of the Board of Trade. 8. Bye-laws of the County Council in reference to overhead wires. 9. Electrical communication on the coasts. 10. Commercial education:—To consider whether the section would be prepared to support the commercial education scheme of the Chamber by subscribing annually for a prize or prizes to be awarded in the name of the section. 11. Co-operation of the section with the new mining section of the Chamber. 12. Proposed addresses. 13. Other matters.

The Faure Patent in Germany.—The Supreme Court of Appeal at Leipsic has delivered a judgment confirming the decision of the patent office at Berlin and establishing the validity of the Faure patent. Several of the secondary battery manufacturers in Germany had entered process in the patent office, seeking to have the Faure patent declared invalid on the ground that its main features had been anticipated. This contention has now been finally disposed of in favour of the Faure patent. This decision will have an important effect on the secondary battery business in Germany.

Brussels Electric Lighting.—*Industries* states that the decision of the Technical Committee appointed to consider the tenders sent in for the electric lighting of this city, in having awarded the preference to the tender sent in by the India-Rubber and Gutta-Percha Company, is being much criticised.

Electrical Literature.—We hear that owing to the large demand for Dr. J. A. Fleming's "Alternate Current Transformers," a third issue of Vol. I. is now ready. This volume consists of 500 pages (published price 7s. 6d.) and is accepted as a text-book on the subject treated in the Universities and Colleges of Great Britain, the Colonies, and America. Volume II. is in the press, and will be published some time in June, 1892. It will consist of more than 600 pages, will be very fully illustrated, and the published price will be 12s. 6d. Published by *Electrician* Printing and Publishing Company, Limited.

Sad Telephone Accident in America.—The *Western Electrician* records a pathetic case in which a telephone lineman, named James Grant, became insane while testing a Chicago telephone circuit. It is supposed that lightning struck the wire leading to the instrument through which he was conversing. The unfortunate man's delusion that he was still at the telephone, after the shock, and that he was unable to leave it, was very pitiful, and was emphasised by his unceasing cry, "Hello; ring off." It is conjectured by some that the lineman was only stunned by the lightning, and that the injury to the brain was caused by his fall. In any event, the case is an unusual one, and it is to be regretted that more detailed information regarding it is not to be obtained from the medical men.

"The Hole in the Jar."—Everyone who has had anything to do with gravity batteries knows how difficult it is to keep the copper elements in place in the cells. The least disturbance will cause them to get on top of the bluestone, in which condition the cell naturally becomes inefficient. Some simple means, therefore, of avoiding this difficulty would meet with a hearty welcome by those whose duty it is to care for batteries of this type, and who appreciate the vexations caused by this tendency of the copper and bluestone to exchange places. A very simple remedy for this difficulty has been designed and patented by J. Jones and Son, 602 and 604, West Twenty-second Street, New York City, an illustration of which is given herewith. It consists

of providing a hole in the side of the jar near the top, through which the insulated conductor connected with the copper is passed. This is accomplished by passing the wire over the edge of the jar, then bending it over backwards and putting it through the hole, then bending it again upwards. It will thus be seen that a sort of a half-hitch is made with the wire, which holds the copper securely against the bottom of the jar and prevents its easy displacement by ordinary handling of the cells. This simple remedy means a more efficient battery and longer life; the current is, of course, steadier, and the internal resistance of the cell remains practically invariable. The fig. represents the advantage of the new style, showing that it is possible to lift a cell up by the wire without displacing the copper. This simple but ingenious remedy is known by the name of "Hole in the Jar."—*Electrical Age.*

Bazaar at St. George's Hall, Bradford.—A bazaar was opened last week in the St. George's Hall, Bradford, by the Right Hon. Lord Marsham, in aid of the Woodlands Convalescent Home, Rearden, which proved a most successful affair of the kind. The entertainments were varied, and a pleasing feature of the bazaar was that the whole of the stalls and hall were lighted by various electric lamps with fancy shades, the power being obtained from the Bradford Corporation supply. The entire arrangement for electric lighting was carried out by Messrs. Andrews and Preece, Limited, of Bradford, at a very short notice. The hall was lighted with pendants, lamps varying from 200 C.P. to 16 C.P. being used. An interesting exhibit, lent by Mr. J. Reixach, was a model representing "The Nativity," similar to those exhibited in Spain at Christmas time. By means of a number of lights day was represented, and the effect of moonlight, with the "Star of Bethlehem," was made very realistic by similar means. This arrangement was carried out by Mr E. Preece, electrician to Messrs. Lister and Company, Limited, Manningham Mills, Bradford. The result of the bazaar was a financial success, largely due to the voluntary aid given.

The Telephone at Sheffield.—On the 18th inst. an interview took place between the committee appointed at the recent meeting of subscribers, and a deputation of directors of the National Telephone Company. The company, finding the proposed tariff unsuited to Sheffield, had withdrawn it and submitted a new one. The scale of charges under this tariff was an annual payment of £8 for the use of a wire within a mile and a half radius of the Parish Church, or of any exchange within the free radius; an annual payment of £10 for a two mile radius; and a payment of £2 10s. per annum for every half-mile beyond that radius. The charge for private houses would be £7 per annum if they were within the two mile limit. No decision was arrived at, and the matter is to be considered at another meeting. The local press received a letter from the Duke of Marlborough, who thought it "possible that the importance of the protest which had been made may induce the National Company to change its attitude. On the other hand, it is more than probable that a humble person like myself may be of more practical assistance in producing this result than even the protest of your most distinguished subscribers." The committee referred to above also had an interview with the general manager of the New Telephone Company, who stated the terms on which his company were prepared to come to Sheffield. These terms will also be considered at the committee's next meeting, which will be held at a very early date.

Some English Measuring Instruments.—In an article under this heading in the New York *Electrical Review*, Mr. Charles Ffrench writes as follows:—"The modern Englishman is never happy unless he is under Government inspection. An inspector is always at hand to prevent the simple-minded John from being cheated. Indeed, so well is his safety and well being looked after that he has only within the last two or three years been allowed to light his house from electric supply mains. When permission was at last reluctantly given, John would have felt somewhat off the track without governmental aid and advice if he had not had at his elbow the ubiquitous and almighty fire office inspector. This gentleman, at least, knew his own mind (not a very extensive knowledge, perhaps), and, since the prevention of fire was his end and aim, he insisted on three things—you *must* put your wires in casing, inflammable wood casing, if you like, but still casing; you *must* mount your fittings on incombustible materials, no matter if they are hygroscopic or not, and, finally, the insulation *must* amount to so many megohms. The fire office man was not quite clear whether a megohm was a current or a self-induction, but he knew it was good to have plenty of it; the fact that the supply companies insisted on megohms gave him confidence. And so wiring contractors and fire inspectors and other interested parties wandered around hunting for megohms with $200 Wheatstone bridges and galvanometers and a leaky Leclanché cell or two. No two men ever agreed about the number of them when caught, and it generally took longer to test the wiring in a house than it did to put it in." To what particular individual do our readers imagine Mr. Ffrench refers?

St. Pancras Electric Lighting. — The St. Pancras Vestry has decided to supply electricity at 3d. per Board of Trade unit.

The New Telephone Company.—A display of the New Telephone Company's new double-pole instruments took place on Wednesday last at the offices in Cannon Street, when there was a large concourse of visitors.

Society of Arts.—The Albert Medal of the Society of Arts for the present year has been awarded to Mr. Thomas Alva Edison, in consideration of the distinguished services rendered by him to the progress of electric lighting, telegraphy, and the telephone.

Electric Lighting Panic in Barcelona.—Our contemporary, *Bulletin International de L'Electricite*, states that a short circuit between two conductors caused a panic in a café in Barcelona recently. The occupants, frightened by the faint light which formed itself from the arc, fled from the building, believing it to be an anarchist outrage.

Chesterfield and Electric Lighting. — The *Sheffield Independent* understands that a syndicate has been formed for lighting the centre of Chesterfield with electricity. The Town Council will consider the matter at its next meeting. Was not this town the first to adopt electric lighting on the Brush system some 10 years ago?

The Institution of Electrical Engineers.—A contemporary in referring to the recent change which has been made with reference to the system of "Authorised Abstracts" of the Proceedings of the Institution, proposes to publish carefully edited abstracts revised by the speakers themselves. With reference to this, we may remark that our experience of an arrangement of the kind has been by no means satisfactory, as we have found that so-called "revision" has generally meant "re-writing," and we hold that the speaker's remarks as they were originally made should so appear in print, subject, of course, to correction where the reporter has evidently made errors.

American Institute of Electrical Engineers.—The annual meeting of this institute was held on 17th inst. at New York. The general meeting is to be held at Chicago on June 6th, 7th, and 8th, when the following papers are down for reading:—"Electric Coal Mining Machinery," by Elmer A. Sperry, of Chicago. "On the Electro-Magnetic Field," by M. I. Pupin, Ph.D., of Columbia College, N.Y. city. "Long Distance Transmission for Lighting and Power," by Mr. Charles F. Scott, of Pittsburgh, Pa. "A New Rheostat," by Mr. C. E. Carpenter, of Minneapolis, Minn. "A Dynamo Indicator or Instantaneous Curve Writing Voltmeter," by Prof. George S. Moller, of Cornell University, Ithaca, N.Y. "Electro-Technical Education," by Prof. R. B. Owens, of the University of Nebraska, Lincoln, Neb. "The Magnetic Properties of Sheet Iron," by Mr. Milton E. Thompson, of Cornell University, Ithaca, N.Y. "Selective or Individual Signals," by Mr. Thomas D. Lockwood, of Boston, Mass. "Railroad Train Lighting," by Mr. A. H. Bauer, of Chicago. "A Discussion of Circuits Containing Resistance, Self-Induction, and Capacity," by Messrs. Frederick Bedell and Albert C. Crehore, of Cornell University, Ithaca, N.Y. "A Life and Efficiency Test of Incandescent Lamps," by Prof. B. F. Thomas and Messrs. P. Martin and R. H. Hassler, of the Ohio State University, Columbus, Ohio. "Notes on Wiping Contact Methods for Current and Potential Measurement," by Prof. B. F. Thomas, of Columbus, Ohio. "Series Electric Traction, by Mr. Nelson W. Perry, of New York city. "Oil *v.* Air as Insulation," by Dr. J. B. Williams, of New York city. "On the Electrolytic Refining of Copper," by Lieut. F. B. Badt, of Chicago. "The Photography of Alternating Current Curves," by Dr. Edward L. Nichols, of Cornell University, Ithaca, N.Y. "The Reversal of Polarity in Plating Dynamos," also on "Dynamos for Continuous Current Circuits," by Prof. Harris J. Ryan, of Cornell University, Ithaca, N.Y. "The Technical Education of the Electrical Engineer," by Prof. D. C. Jackson, of the University of Wisconsin, Madison, Wis. Papers are also expected from Mr. H. Ward Leonard, Mr. Nikola Tesla, Prof. Elihu Thomson, and Prof. George D. Shepardson, the subjects of which cannot be announced at present.

Government Telegraphs. — The *Times* of yesterday stated that Sir J. Fergusson had given notice of introducing a Bill to make further provision respecting telegraphs.

Our Contemporaries.—The May issue of the *Manufacturers' Engineering and Export Journal* contains a capital description of the North Woolwich works of W. T. Henley's Telegraph Works Company, to which is appended a number of excellent illustrations.

NEW COMPANY REGISTERED.

Cambridge Electric Supply Company, Limited.—Capital, £50,000 in £10 shares. Objects: To carry on the business of electrical engineers, electrical contractors, and undertakers for the supply of electricity for light, transmission of power or otherwise, and to take a transfer of the powers, duties, and liabilities granted to and imposed upon the mayor, aldermen, and burgesses of Cambridge by the Cambridge Electric Lighting Order, 1890. Signatories (with 1 share each): Sir B. C. Browne, Westacres, Newcastle; J. B. Simpson, Edgefield House, Blaydon-on-Tyne; C. A. Parsons, Heaton Works, Newcastle; W. Bond, 3, Brookside, Cambridge; G. B. Finch, 1, St. Peter's Terrace, Cambridge; G. Whitmore, 4, Salisbury Villas, Cambridge; W. S. Melsome, Queen's College, Cambridge; W. R. Lamb, The Hall, Ryton-on-Tyne; H. C. Harvey, 57, Westgate Road, Newcastle. The number of directors is not to be less than three nor more than seven, the first being William Bond, Sir B. C. Browne, G. B. Finch, Hon. C. A. Parsons, J. B. Simpson and G. Whitmore. Qualification, £250; remuneration as may be determined by the company in general meeting. Registered on the 18th inst. by E. Flux, Leadbitter and Paterson, 144, Leadenhall Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

British Insulated Wire Company, Limited. — At extraordinary general meetings of the above company, held on February 10th and March 4th, a resolution altering one of the articles of association was passed and confirmed respectively. Registered office, Prescot, Lancashire.

Bath Electric Light Company, Limited.—This company was dissolved under clause 7 (4) of the Companies Act, 1880 (43 Victoria, ch. 19), by notice in the London *Gazette*, dated May 10th, 1892.

British Electric Propulsion and Traction Company, Limited.—The registered offices of this company have been removed from 50, Gresham Street, E.C., and are now situate at the Victor Works, Holloway, N.

Islington and General Electric Supply, Limited.—Mr. Justice Chitty, in the High Court of Justice, Chancery Division, on May 10th, 1892, ordered that the words "and reduced," as part of the title of the company, be dispensed with.

Benham and Froud, Limited (art metal workers and electric light fittings manufacturers).—The annual return of this company, made up to the 11th inst., was filed on the same day. The nominal capital is £50,000 in £10 shares. 2,907 shares have been taken up, and the full amount called. The total amount of calls paid is £28,852 10s., and unpaid calls amount to £217 10s. Registered office, 10, 41, and 42, Chandos Street, Strand, W.C.

Chloride Electrical Storage Syndicate, Limited.—The statutory return of this company, made up to the 4th inst., was filed on the 20th inst. The nominal capital is £262,500, divided into 250,000 preference and 12,500 founders' shares of £1 each. Of these 48 founders' and 11,927 preference shares have been taken, upon each of which the full amount has been called. The calls paid amount to £9,966 10s., and unpaid to £2,008 10s. Registered office, 13 and 14, Abchurch Lane, E.C.

Syndicate of Electrical Engineers, Limited. — The annual return of this company, made up to May 14th, 1891,

was filed on the 30th ult. The nominal capital is £10,000, divided into 1,900 ordinary and 100 founders' shares of £5 each. Of these, 1,007 ordinary and 74 founders' shares have been taken up, and £2 per share has been called on the ordinary, resulting in the payment of £1,903 10s., and leaving £110 10s. in arrears. Of the founders' shares no mention is made as to whether they were issued as fully paid or not. Registered office, 15, St. Helen's Place, E.C.

W. T. Henley's Telegraph Works Company, Limited.—The annual return of this company, made up to the 7th ult., was filed on the 12th ult. The nominal capital is £100,000, divided into 7,000 ordinary and 3,000 7 per cent. preference shares of £10 each. 6,727 ordinary and 2,092 preference shares have been taken up, and the full amount called. The calls paid amount to £83,330, and leaving £4,860 in arrears. Registered office, 27, Martin's Lane, Cannon Street, E.C.

LEGAL.

Smith v. Edison's United Phonograph Company.—Mr. Justice Day and a jury, sitting in the Queen's Bench Division, last week, heard the case of Smith *v.* Edison United Phonograph Company. The plaintiff, Mr. Currer Smith, claimed damages for breach of an agreement to permit him to form a syndicate in England and for refusal to appoint him manager of the syndicate when formed. The defendants denied any agreement as alleged, and said there were merely negotiations, which were subject to ratification by the directors in New York. The particular machine, in respect of which the present action was brought, was an automatic phonograph to stand on railway platforms, and on a penny being inserted in the slot the machine delivered a song by Madame Patti or a celebrated tenor, or a portion of an opera. A committee, consisting of Colonel Gourand and two other gentlemen, came to England and took premises in Northumberland Avenue. The plaintiff made an offer to this committee for concessions to form separate companies, or, for agencies for specific districts. It was arranged that if the plaintiff could form a syndicate with a nominal capital of £75,000, he was to receive £7,500 cash, and a salary of £100 a month while the company was being carried through. The defendants afterwards authorised the plaintiff to take suitable offices to show the machines, and invite the public that subscribed to the proposed syndicate to see them. The plaintiff took offices in Warnford Court, and paid part of the rent. The defendants now sought to repudiate the agreement, on the ground that the committee in England had not power to bind the company. Mr. Currer Smith had spent a lot of money and time in trying to form the syndicate, and claimed damages for the loss of his services.

The case occupied a whole day, and at the close the jury gave a verdict for the defendants, and judgment was entered accordingly.

The Western Counties and South Wales Telephone Company v. the Bournemouth and District Electric Lighting Company, Limited.—In this case, which was a motion which came before Mr. Justice Chitty, for a writ of sequestration against the Bournemouth and District Electric Lighting Company for disobeying an order of the court restraining them from so working their system as to interfere with the telephonic exchange of the plaintiff company, Mr. Byrne, Q.C., applied for further time to consider fresh affidavits. His Lordship directed that the motion should stand over for a week.

Pepperell v. the City and South London Railway Company.—In the Queen's Bench Division, on Monday last, Mr. Justice Wills gave judgment in the case of Pepperell *v.* the City and South London Railway Company. His lordship said the plaintiff claimed damages for injuries he sustained by falling off the platform on to the line in consequence of the station being imperfectly lighted and no porter being in attendance to give warning that the plaintiff was at the edge of the platform. The accident happened in July of last year. He (the judge) thought the accident was brought about by the plaintiff's shortsightedness or want of precaution; that he was looking about him, and being interested in the novelty of the scene, got too near the edge and fell over. He was unable to see that there was anything defective in the arrangements at the station, and therefore gave judgment for the defendant company, with costs. His lordship granted a stay of execution.

BUSINESS NOTICES, &c.

Electric Light Lamp Pillars.—Messrs. George Smith and Co., of the Sun Foundry, Glasgow, and 1, Dowgate Hill, E.C., have just perfected and patented what seems to us a good idea for the purpose of ascending, as required, the long electric lamp pillars now occasionally met with in our streets. The invention consists of an easy means of ascending the pillars without the trouble of carrying long ladders, &c. The method adopted is to have a simple mechanism *inside* the shaft of pillar, which, by the turn of a key or handle, or the movement of a lever outside the base, steps are shot out from the sides of the shaft, sufficiently far to form a safe and strong ladder; these steps, when closed, are arranged to form part of the ornament of the shaft, or they can be made to form a part of the plain or fluted surface. It will be at once seen that several good points are gained by means of this invention. In the first place the steps of the ladder, when closed up, form part of the ornament of the pillar, so doing away with the necessity of having those hideous looking knobs, or foot rests, which we see at present on the old style of electric pillars. In the next place it saves the workmen the trouble of carrying ladders, or, as is often required, bundles of sticks to fix into holes made in the castings, while, at the same time, it gives a much surer foothold, the ladder being, as it were, part of the main castings, and perhaps one of the most important points is that it cannot show on the sides the mud and dirt from the feet. We have inspected a model of this new invention, and we feel that it has a good future before it. We may mention that Messrs. George Smith & Co. have the contract, and are at present supplying the new electric pillars for the City of London, which, in design, are so much more effective than the old ones, and, for excellence of workmanship, are much admired.

Electrical Work in Johannesburg.—We hear that electric light installations in Johannesburg are daily becoming more numerous. Messrs. Woodhouse & Rawson are fitting up, amongst others, the Market Buildings, the Grand National Hotel, Globe Theatre, Masonic Hotel, Heath's Hotel, Telegraph and Postal Offices, and the Rand Club. The work is being superintended by Mr. Cousens, M.I.C.E. The same firm are putting up some machinery for pumping up an extra supply of water from the New Primrose Mine. Telephone poles are being erected for the purpose of connecting the Village Main mine with the offices of the owners.

Tenders Wanted—Hanley.—The Corporation of Hanley invite tenders for the execution of works required for the supply of electricity within the borough, in accordance with the Hanley Electric Lighting Order, 1891. Plans and particulars may be obtained from Mr. Joseph Lobley, M.Inst.C.E., borough engineer, on payment of two guineas, which sum will be returned on receipt of a *bonâ fide* tender within the specified time. Sealed tenders, endorsed "Tender for Electric Lighting Works, to be sent to Arthur Challinor, Town Clerk, before noon on Monday, June 20th next.

Tenders Wanted—Telegraph Poles, &c.—For the supply of red fir telegraph poles, to be delivered in London, King's Lynn, or Sutton Bridge; at Northumberland Dock (river Tyne), West Hartlepool, Hull, or Grimsby, and at Cardiff or Gloucester. Forms of tender, containing all particulars, may be obtained on application to Mr. C. E. Stuart, controller of stores, Telegraph Street, London, E.C. Tenders will be received until noon, June 24th.

Tenders Wanted, Hull.—The Hull Corporation are inviting tenders for supplying and erecting a switch and distributing board. Full information will be found among our advertisements.

Electric Launches.—The electric launch *Myionu* left Strand-on-the-Green, Chiswick, on Sunday last for Windsor. She was designed and moulded by Mr. W. S. Sargeant, whilst manager last year for Messrs. Woodhouse & Rawson, and was built by them for Captain Homfray, of the Horse Guards. The hull is constructed of mild steel, and is fitted with a very handsome teak cabin. The electrical power consists of 40 E.P.S. accumulators with high speed propeller connected up direct with the armature shaft, and rotating at about 650 revolutions per minute.

Failure of an Electrical Engineer.—A meeting was recently held at the offices of the Manchester Official Receiver of the creditors of F. G. Williams. In October last the debtor commenced business as an electrical engineer at Denton, under the style of Kenyon & Co., the main object of the business being to establish a telephone exchange. The statement of affairs submitted by the debtor showed liabilities £791 6s. 8d., and assets estimated to produce £816 18s., there being thus a surplus. A committee of inspection was appointed.

Royal Military Tournament.—The electric lighting of the Royal box and the officers' quarters and offices has been carried out by Messrs. Woodhouse and Rawson United, Limited, Epstein accumulators of the "Country house or private installation" type being used as a reserve. Two balloon lights, and also "Scott's signalling lantern," by which Morse signals are flashed, have also been provided by this company. The whole of this work was carried out in three days.

New Business.—The Wray Electrical Engineering Company has commenced business at Thornton Road, Bradford, as electrical engineers and manufacturers of dynamos, arc lamps, &c. Mr. Cecil Wray has the management of the business. The company have several installations in progress, including the lighting of Rufford Lodge, Dewsbury, for Mr. C. B. Crawshaw.

Electric Lighting of Lytham Pier, Lancashire.—Referring to the note on this subject in our issue of 13th inst., we are informed that the contract for the lighting of Lytham Pier by electricity has been secured by Messrs. H. A. Clegg & Co., of St. Mary's Street, Manchester.

The Electric Light in Islington.—The premises of Messrs. Lipton, the well-known provision dealers, near the Angel, Islington, are being installed with the electric light by the London and Lancashire Electric Company, of Upper Thames Street, E.C.

Electric Light in the City.—We note that Messrs. Smeeton and Page have just finished putting a complete plant for 50 lights in the offices of the Commercial Telegram Bureaux, Tokenhouse Yard, E.C.

The Electric Light at Ardrossan.—The harbour at Ardrossan, N.B., is to be lighted with the electric light. The contract has been secured by Messrs. Mavor and Coulson, of Glasgow.

CITY NOTES.

Elmore's French Patent Copper Depositing Company, Limited.

AN extraordinary general meeting of Elmore's French Patent Copper Depositing Company, Limited, was held at the Cannon Street Hotel, on the 21st inst., when the following extraordinary resolution, which was passed at the general meeting of the company held on the 22nd April, 1892, was submitted for confirmation as a special resolution:—

"That the capital of the company be increased to £400,000, by the creation of 100,000 new shares of £2 each. Such new shares shall be called preference shares, and shall be entitled to priority on a distribution of assets, and shall also be entitled, out of the profits available for distribution in each year, to a preferential dividend of 10 per cent., and to a further dividend of 5 per cent, after a dividend of 15 per cent. has been paid on the existing shares of the Company, which shall in future be called ordinary shares."

Major CHARLES JONES presided, on account of the indisposition of the chairman, Sir Richard Meade.

Major JONES, in moving the adoption of the above resolution, said that it was simply a formal meeting, as the whole matter was fully discussed at the meeting held some days before, and the resolution was there passed without any dissentients. He would only add that they had been having very good reports from France—everything was going very well there. Since the last meeting their circular had been issued to the trade, and the replies were very satisfactory, and trial orders were being sent in from a very large number of houses, including some of the very best houses in France. They were being executed, and the work was progressing in a satisfactory manner. He then moved the confirmation of the resolution increasing the capital of the company.

This was seconded by Sir JAMES MCKENZIE.

A SHAREHOLDER wanted to know whether the mandrils were really producing 80 tons of tubes per day, as per Mr. Secrétan's report. He thought the shareholders ought to have the monthly returns placed before them, showing what the actual monthly product had been.

Replying to these and other remarks, the chairman stated that one of the shareholders who had spoken was mistaken in thinking that the works were actually, in the beginning of January, turning out that 80 tons per day. All that the chairman reported at the last meeting was that the works were completed, that they had a plant established which was capable of turning out that quantity of work. A large factory like that in France—as any engineer or manufacturer would say—would take a considerable time to work, first of all, even if they had the orders; next, it would take a considerable time to work the factory up to that full output. They had to instruct their men and to get the whole organisation in order. The fact was that nothing like that quantity had ever been manufactured. Mr. Secrétan's was the correct statement, that there were 80 tanks, turning out about 100 tubes per day, and that was being done now. The output was approximately, perhaps, a little better than it was when they met last, but it had not actually increased. The output of tubes for sale had not increased very materially, for they had been occupying tanks which would otherwise have been used for tubes, in cutting mandrils. They had to stop the tanks while they were waiting for mandrils.

In reply to another shareholder he stated that they were at present turning out about 9 to 10 tons per week. The fact that the works were in order was a very different thing to working the factory up to its full output. The output would gradually go on increasing. Mr. Secrétan was pushing on as fast as he could, but he did not want to push on too fast and make bad things. They would consider the question of giving the shareholders the monthly returns. If anyone would call at the office, they would be glad to give them any information about the French returns. As regards the preference capital, the amount which they had actually allotted was between £24,000, and £25,000, and the board were, in addition, making arrangements under certain conditions which they saw no difficulty in fulfilling, for placing another £40,000.

Asked why they wanted this extra, he stated that it was to pay for the extra expense of the factory, and to provide working capital to go on with. They had power to borrow money up to half the capital, and the directors had exercised their authority in the interests of the shareholders.

In reply to a question as to *when* the output would reach 300 tons, he was not able to forecast, but it would gradually increase.

The resolution was then put to the meeting and carried, and the proceedings terminated.

La Compagnie Continentale Edison.

THE report of the above company presented to the ordinary general meeting was as follows:—"Despite the unfavourable state of things in general, and the competition which every day renders our working more difficult, we have to present to you for the past year results sensibly similar to those of 1891. In appropriating to new amortisements a sum of 263,138 francs, the accounts show a net profit of 437,251 francs. The working of the sector conceded to our company by the City of Paris has markedly developed. On March 31st, 1891, we had 29,782 10-candle lamps installed; on the same date this year we had 43,942. Our Dronot and Trudaine central stations, of which the power has been raised to 2,700 horses, have been capable of ensuring the service; but we foresee that it will be necessary, in order to meet the needs of next season, to increase their present power. These are circumstances of a nature to make us indulge in well-founded hopes, were it not that we have to occupy ourselves in the transformation of certain portions of our canalisations, and in the necessity of providing for considerable amortisements in view of the short duration of the concession. As to the Palais Royal station, which assures the Elysée Palace service; to that of the Opéra, the results of which can only be improved by an increase in the number of performances; and to our other workings, they all continue to work with the utmost regularity. The sale of material, which we manufacture at our Ivry works, has, unfortunately, not developed in such a satisfactory manner as has the sale of light. We have nevertheless furnished the material for the central works of Avignon, Sisteron, Moulins, Guéret, La Mure, &c., and all our efforts tend to give more activity to this branch of our industry. The Ministry of Marine and the railway companies have begun to make applications for our new slow working dynamos, the results of which permit us to hope for large orders. We are also ready to meet the orders which transport companies cannot fail to send us for electric traction. The Moscow Exhibition involved expenses which will not be wholly sterile in the future. Our company had the satisfaction of seeing its exhibits highly appreciated. (M. Vernes, its chief engineer, was named a Knight of the Legion of Honour.) A portion of the material shown served for the creation of a central municipal station at Odessa, which, attracting the attention of the manufacturers of this vast friendly country, will help us to increase our business in Russia. The 4,000 5 per cent. bonds of 500 francs created in October, 1890, have been wholly taken up. In order to meet the growing lighting demands, the Council decided, in January, 1892, by virtue of Article 23 of the statutes, to create 2,000 bonds of a similar nature and value, but their realisation will only be effected in proportion to the needs of the company. The profit and loss account is set forth in the following table:—

Credit.	Francs.
Interest and charges	19,287.20
Interest and dividends on securities in portfolio	72,667.80
Net profit on the sale of materials	246,734.43
Profit on working of the central stations and other installations, an increase of 315,990 francs 38 centimes over 1890	819,949.75
Miscellaneous	26,413.39
Total.	Francs 1,185,052.47

The general expenses and amortizations having been 147,801 francs the profit was 437,251 francs, from which must be deducted 5 per cent. for the legal *reseau*, 21,862 francs, leaving 415,388 francs brought forward from 1890, 10,007 francs, showing a total of 425,396 francs, of which 400,000 francs will be devoted to a dividend of 20 francs per share, and the remainder, 25,396 francs, will be carried forward.

The Islington and General Electric Supply, Limited.

THE prospectus of this company, which was issued yesterday by the Exploration Company, Limited, states that the company has Parliamentary powers for Islington, with 319,000 inhabitants; and for Camberwell, with 235,000 inhabitants. A small portion of the latter district is excepted, however, in favour of the Crystal Palace and District Lighting Company. A canvass was made of the two principal streets in Islington, and the requirements of the tradesmen and others, indicated by such canvass, amounts to over 20,000 8-C.P. lamps. It is intended to erect a station immediately, and as the demand exists in other parts of Islington and Camberwell, it is proposed to erect altogether three stations. The total capacity is estimated to be 100,000 lamps of 8 C.P. installed. The contracts for two stations and other work has been entered into with Messrs. J. E. H. Gordon and Co, for sums amounting to £144,000, out of which amount they will subscribe for £20,000 shares in the company. The share capital is £250,000 in £5 shares, of which £225,000 are at present open for public subscription. The directors are Sir Frederick A. Abel, K.C.B., F.R.S., E. W. Barnard, Major-General Arthur Ellis, C.S.I., Sir Richard Pollock, K.C.S.I., R. W. Wallace. Engineers: Prof. A. B. W. Kennedy and Mr. V. B. D. Cooper. Mr. Gisbert Kapp is consulting electrician to the company. Registered office, 5, Victoria Street, Westminster, S.W.

Electricity Supply Corporation.—The Electricity Supply Corporation, Limited, offers for subscription £100,000 in shares of £5 each, and £70,000 in 5 per cent. debentures, redeemable at par in 1900. The company was incorporated on June 12th, 1889, for the purpose of obtaining a provisional order for the supply of electric light and power within the parish of St. Martin-in-the-Fields. It is stated in the prospectus, that the company is already supplying 22,000 8-candle-power lamps. The existing plant is capable of supplying the requisite current for 40,000 lamps hung, and, with a small addition of boiler power, is equal to supplying 60,000 8-candle lamps hung. The proceeds of the present issue will be applied in discharge of the present debenture and other debts of the company, which include moneys advanced by Messrs. Gatti, and sums payable under agreements with them in respect of rights over their properties in the neighbourhood, and about £20,000 will be left for working capital.

Spanish National Submarine Telegraph Company.—The numbers are announced of 86 bonds of £100 each of the 6 per cent. mortgage debentures, for payment at par on and after June 30th next.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 20th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, amounted to £2,803.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation, May 19th.	Closing Quotation, May 26th.	Business done during week ending May 26th, 1892. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 —103	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	48½— 49½	48 — 49	48	...
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	88 — 89	88 — 89	89	87½
2,849,510*l*	Do. do. Deferred	Stock	11½— 11⅝	11½— 11⅝	...	...
130,000	Brazilian Submarine Telegraph, Limited	10	10½— 11	10½— 11	10⅝	10½
53,200*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —108	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3½	3 — 3½	...	...
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2½	2 — 2½	2¼	2 1/16
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½— 4½	3½— 4½	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½— 3½	2½— 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	7¾— 8¼	7¾— 8¼	8	7¾
$7,716,000	Commercial Cable, Capital Stock	$100	158 —163	158 —163	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	1/8— 3/8	1/8— 3/8	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½— 5⅝	5½— 5⅝	...	...
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	11 7/16	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	16⅝	16½
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼— 3⅜	3¼— 3⅜	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11½— 11¾	11½— 11¾	11⅞	11⅝
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14¾— 15	14¾— 15	15	14 1/16
70,000	Do. 6 p. c. Preference	10	15½— 15⅝	15½— 15⅝	15⅝	15½
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109	106 —109	108¼	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	108 —111	108 —111	110½	109
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞— 15⅛	14⅞— 15⅛	15⅛	14⅞
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	104½	104
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	108 —111	108 —111	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104	101 —104	101⅞	101¾
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5¾— 6¼	5¾— 6¼	6	5¾
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅛— 1⅜	1⅛— 1⅜	1 7/16	1⅛
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2¼— 2½	2¼— 2½	2⅝	2 1/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd,	2	1⅛— 1⅜	1⅛— 1⅜	1 7/16	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10⅛— 10⅜	10⅛— 10⅜	10⅜	10 1/16
180,042	Do. do. 6 p. c. Preference	10	15⅜— 15⅝	15⅜— 15⅝	15⅝	15⅜
150,000	Great Northern Tel. Company of Copenhagen	10	18¾— 19¼xd	18¾— 19¼	...	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	106 —109	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7¾— 8¼	7¾— 8¼	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	19½— 20½	19½— 20½	20⅛	19¾
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —105	102 —105	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 41	40 — 42	41	40½
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	4 — 5	3½— 4½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 7/16— 3 9/16	3 7/16— 3 9/16	3½	3⅜
10,000	Do. do. fully paid	5	5 1/16— 5 1/16	5 1/16— 5 1/16	5¼	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7xd	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	7½— 8 xd	7½— 8	7⅞	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4¼— 4½	4⅝	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	13 — 13½	13 — 13½	13½	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12¼— 12⅝	12¼— 12⅝	12 7/16	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	107 —109	107 —109	108⅜	108½
250,000*l*	Do. (issued at 5 p.m., all paid)	...	104 — 106	104 —106	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4½— 5½	4 — 5	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	5/16— 7/16	5/16— 7/16	...	...
9,000	Reuter's Limited	8	6 — 7	7 — 8	7¼	6¾
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8½— 9	8½— 9	...	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7⅞— 8¼	8 — 8½	8¼	...
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	115½	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3¾— 4¼xd	3½— 4	3 13/16	...
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	44	43⅜
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	1½— 2½	1½— 2½	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	99⅜	...
30,000	West Coast of America Telegraph, Limited	10	3¼— 4½	3½— 4½	3⅝	3 11/16
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	102 —106	...	...
67,007	Western and Brazilian Telegraph, Limited	15	9½— 10	9½— 10	9⅜	9⅜
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6⅜	...
30,364	Do. do. do. 5 p. c. Deferred	7½	3½— 4	3½— 4	3½	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	105 —108	105 —108	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	105 —108	105 —108	...	...
88,321	West India and Panama Telegraph, Limited	10	1½— 1⅝	1½— 1½	1⅝	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10⅜	10½
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9 — 10	9 — 10	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	102 —106	102 —106	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	115 —119	115 —119	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	10J	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6½— 7	6½— 7	...	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7⅛—7⅜.—Electric and General Investment, shares of £5 (£1 paid), 2—2⅛.—Founders' shares, 150—200.—Elmore Foreign and Colonial Copper, Founders' shares, 6¾—7⅛.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable, 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2⅛—3⅛.—7 per cent. Preference Shares of £5 (fully paid) 5¼—5⅜.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅞—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5¼—6.—Liverpool Electric Supply Shares of £5 (fully paid), 5 1/16—5 3/16.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—⅜.—Metropolitan Electric Supply Company, Foundors' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—¼.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—¼.—Do. Debentures, 108—⅜.—Woodhouse & Rawson Ordinary of £5 £2 10s. paid), ⅛—⅜.—£5 Preference (fully paid), 2½—3.—Ward's Electric Car (£10 paid), 1⅜—1⅝.

BANK RATE OF DISCOUNT.—2 per cent. (April 28th, 1892).

NEW PATENTS—1892.

8,743. "Improvements in couplings for electric wires." A. SHIELS. Dated May 9th.

8,745. "Improvements in switches for electric light work." B. M. DRAKE and J. M. GORHAM. Dated May 9th.

8,768. "Improvements in and relating to mechanically driven alternating dynamo-electric machines combined with an electric lamp." W. P. THOMPSON. (Communicated by S. Hellebrandt, Austria.) Dated May 9th.

8,779. "An improved process for the preparation of iron or steel plates to receive electro-plating of other metals, such as silver, gold, or nickel." J. B. CHAMBERLAIN and A. GUTENSOHN. Dated May 9th.

8,789. "The 'Adams' electro-tubular pneumatic action for improvement of organs." G. H. ADAMS. Dated May 10th.

8,805. "Improvements in dynamo-electric machines and electric motors." H. N. PRENTICE. Dated May 10th.

8,829. "Improvements in or relating to the establishment of communication between lighthouses, light and other vessels or structures and the shore." A. J. BOULT. (Communicated by R. Pitt, Italy.) Dated May 10th.

8,837. "An improved non-consumable electric light candle or a non-consumable candle for arc lamps." T. ARMSTRONG and C. HASCALL. Dated May 10th.

8,838. "Improvements relating to the application of electricity to spring mechanism." A. E. VIDAL. Dated May 10th.

8,854. "Improvements in fittings for electric lights." J. SMALLWOOD. Dated May 10th.

8,894. "A type-writing electric telegraph." A. E. HARDAKER. Dated May 11th.

8,898. "Improvement in electric contact-making device." G. K. B. ELPHINSTONE. Dated May 11th.

8,923. "Improvements in apparatus for establishing communication between a stranded ship and the shore for life saving purposes." J. B. NOBLE and C. G. THOMSON. Dated May 11th.

8,986. "Improvements in mains and conduits for electric cables, and in collars and connections for same." D. RYLANDS. Dated May 12th.

8,987. "Improvements in secondary batteries and accumulators." P. GERMAIN. Dated May 12th. [Date applied for under Patents Act, 1883, Sec. 103, February 23rd, 1892, being date of application in France.]

9,002. "Improvements in connectors and like appliances for electric lighting and kindred purposes." W. MACPHERSON and A. J. HOWES. Dated May 12th.

9,014. "Improvements in storage batteries." H. J. ALLISON. (Communicated by P. Kennedy and C. J. Diss, United States.) Dated May 12th.

9,036. "Improvements in electrical accumulators." R. BRADLEY, N. L. POCOCK and W. BROWN. Dated May 12th.

9056. "Improvement in means for electrically giving reciprocating motion." H. S. MCKAY. Dated May 12th. (*Complete.*)

9,105. "An improved column-printing telegraph for facilitating the receiving and transmission of messages." C. A. BECK and L. KAMM. Dated May 13th.

9,108. "Improvements in or connected with electric batteries." C. P. SHREWSBURY, and J. L. DOBELL. Dated May 13th.

9,110. "Improvements in microphones or transmitters." G. A. NUSSBAUM. Dated May 13th.

9,132. "Improvements in heating and welding by electricity." H. HOWARD. Dated May 13th.

9,136. "Improvements in or relating to electric alarms." R. THORN. Dated May 13th. (*Complete.*)

9,142. "Improved combined building block and electric insulation." A. L. FYFE. Dated May 13th.

9,147. "Improvements in or connected with electric fittings, such as fuse blocks, ceiling roses, switches, and the like." P. G. EBBUTT and J. B. VERITY. Dated May 14th.

9,148. "Improvements in swing joints or ceiling connections, for carrying suspended electric light fittings, or combined electric light and gas fittings." P. G. EBBUTT and J. B. VERITY. Dated May 14th.

9,185. "Improvements in couplings for electric wires." A. SHIELS. Dated May 14th.

9,192. "Improvements in the electrolysis of chloride and other solutions." A. J. BOULT. (Communicated by F. C. Bromley, France.) Dated May 14th. (*Complete.*)

9,197. "A process of extracting zinc, iron, lead, and copper from the solutions of their salts by electrolysis." A. J. BOULT. (Communicated by E. Liebert, Belgium.) Dated May 14th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

3,404. "Improvements in switches for telephone circuits." C. H. ELLIOT and E. F. FURTADO. Dated February 25th. Relates to a switch whereby a number of telephone stations can call each other without first calling to a central point, and so that on hanging up the receiver, the switch shall automatically return to the individual line belonging to the instrument, to be in readiness for the next call. 3 claims.

7,949. "Improvements in secondary batteries." P. GOWARD. Dated May 8th. Inside a lead cylinder is placed a smaller cylindrical vessel with a closed bottom. This vessel may be of porous earthenware or other non-metallic material, and it is pierced at the sides with a number of holes. The space between the two cylinders is packed with finely divided or spongy lead, or with a peroxide of lead obtained by electrolysis. The outer lead cylinder has a number of inverted V or U-shaped incisions made in its sides, and the flaps formed by these incisions are bent over inwards, forcing them into the spongy material between the two divisions, thereby consolidating and retaining it in place. The cylinder, thus arranged and packed, forms the positive electrode. A strip of lead is attached by "burning" to the outer cylinder, for the purpose of connection with an adjacent element, or with an outside circuit. At the bottom of the earthenware cylinder a shallow vessel is placed, formed of some non-conducting material, such as celluloid, containing a small quantity of mercury, and within the earthenware vessel, and with its lower edge dipping into the mercury, is placed a sheet of zinc formed into a cylinder, and extending from the bottom to the top of the vessel. This forms the negative electrode, and it is provided with a strip of lead for connection either with an adjacent element or with an outside circuit. 3 claims.

11,134. "Improvements in apparatus for the electrolysis of chloride of aluminium." C. A. FAURE. Dated June 30th. Claims:—1. In apparatus for the electrolysis of chloride of aluminium, a cylinder charged with chloride of aluminium, and so arranged that the chloride of aluminium therein will melt and maintain a constant level of the bath in the tank or vessel wherein the chloride is decomposed, substantially as herein described. 2. Apparatus for the electrolysis of chloride of aluminium, comprising a tank or vessel for containing the melted chloride of aluminium to be decomposed, in which are immersed carbon electrodes fixed to a conductor, said tank or vessel being connected with another conductor, and provided with an outlet for molten aluminium, and with a stoneware partition adapted to protect its upper part from the action of chlorine, and to prevent the chlorine from passing into a supply vessel or chamber containing solid chloride of aluminium, substantially as herein described. 3. The improved apparatus for the electrolysis of chloride of aluminium and production of aluminium, and for receiving chloride of aluminium carried over with the escaping chlorine, substantially as described and shown.

12,117. "Improvements in electric current meters." E. HARTMANN and W. BRAUN. Dated July 16th. Relates to means for measuring electric currents by the expansion of a conductor through which the current is caused to flow, and it consists in an improved mechanical arrangement whereby a differential action is produced, and the movement resulting from the expansion of the conductor is converted into a movement of the indicator of relatively great amplitude. 3 claims.

12,257. "Improvements in the manufacture of electric incandescence or glow lamps." P. SCHARF and R. LATZKO. Dated July 18th. Consists in using leading-in conductors of the common metals, such as copper, iron, &c., joined to a coating of a noble metal fused to the glass. 4 claims.

14,379. "Improvements in methods of and apparatus for giving increased life and efficiency to arc light carbons." N. M. GARLAND. Dated August 25th. Chiefly relates to a protective tip or shield of refractory material for increasing the life and efficiency of an electric arc light carbon. 37 claims.

CORRESPONDENCE.

Inductor Dynamos.

As one who has worked out several forms of these alternators, I may be allowed to give my reasons for pursuing this line of improvement. In the first place, the coils exciting and inducing being fixed, winding and insulation are made simpler and cheaper; secondly, one or two coils only are required for exciting; thirdly, the parts may be fewer and of simpler design than in any other form of ordinary alternator; fourthly, in large alternators the advantages of inductor dynamos are more apparent than in small alternators.

Some inductor alternators brought out have failed, but the failure in every case has been due to very obvious faults in design, both mechanical, and electrical and magnetically, and not due to any failure in the principles of the inductor alternator.

The mechanical, electrical and magnetic defects in machines of this class hitherto brought out are not inherent in the principle, and every one of them can be, and has been, eliminated in most recent machines.

Examined critically, many faults can be found quite as serious in the ordinary alternators in every-day use. Large

alternators are made, sold, and used, with many obvious defects in design, and these machines have never been critically tested by independent experts, but it is easily seen from their design and construction that they could not stand fair testing and dissection. The alternating dynamo has not reached that state of perfection attained by the continuous current dynamo. There is plenty of room for improvement; mechanically and electrically, the inductor dynamo may be one solution of the problem.

Another interesting point in alternating current working made prominent in your leading article is, that one eminent electrician, at least, believes in the alternating system. Mr. Preece is quite right in his opinion that alternating currents are better than continuous for motive power, charging batteries, and depositing metals; but the statement ought to be qualified by the proviso that the alternating currents must be multiphase currents—multiphase currents to carry the electrical energy from the generating stations to the sub-stations at high pressure. At sub-stations multiphase currents can be safely, easily, and economically converted into continuous current of low pressure, or alternating current of low pressure, for distribution.

The simple alternating current systems now in use are not any better than low pressure continuous systems; to get the advantages of alternating high pressure transmission, combined with low pressure distribution, two-phase or three-phase currents must be used.

The present favourable adoption of low pressure continuous current central station systems by a number of corporations, on the advice of professedly skilled engineers, may be all very well for a start in electrical supply business, but a day of reckoning is not far off when the said corporations will be called to account for vast expenditure, and very little to show for it but copper buried in the streets, and an unsteady supply. It is comforting to know that these low pressure mains can be tacked on to a high pressure multiphase supply, thereby getting over the inevitable and serious difficulties the corporations adopting low pressure continuous currents have yet to meet.

R. Kennedy.

The Mutual Company's Telephone.

On page 654 of your issue of this week, in a review of the telephones exhibited by this company at the Crystal Palace Electrical Exhibition, the writer states that from a "cursory examination of the Mutual Company's telephone, it scarcely seems to be an instrument likely to yield very satisfactory results."

He will, I am sure, pardon the suggestion that a *trial* of the instrument would have been a fairer criterion; and he will also, I am sure, in the same spirit of fairness, be willing to read the accompanying expressions of opinion from *users* of the telephone.

To paraphrase an old saying, "the proof of the telephone (as in most things electrical) is in the exhaustive trial."

The Mutual Company's executive are well able to defend themselves; I do not write on their behalf, but as this company manufactured the instrument referred to, and as we wish to retain the character of none but the best productions, I trouble you with this letter.

W. J. M. Menzies.

Consolidated Telephone Construction and Maintenance Company, Limited.

May 24th, 1892.

The Purification of Sewage by Precipitation.

You did well to disclaim responsibility for the figures shown in your issue of the 22nd ult. under the above heading, so far as they relate to the International Company's process of sewage purification.

Your correspondent professes to set out the quantities of albuminoid ammonia found by Dr. Burghardt in ten effluents from Salford sewage after treatment by the International system. As Dr. Burghardt only examined *seven* effluents produced by the International process, your correspondent would appear to have drawn on his own imagination for the figures in the three extra cases he professes to quote.

His inaccuracies do not stop short at this big blunder. Of the seven International effluents Dr. Burghardt actually examined and reported on, your correspondent is right in *two cases only* and wrong in five.

We doubt whether your readers have heretofore had such "interesting figures" served up for their delectation. It is only fair to let them know that in the report published by the Salford Corporation, from which your correspondent quotes, Dr. Burghardt says of the effluents produced by the International Company's process of purification:—

"It will be seen from the table of analyses appended to this report that effluents No. 6, No, 9, and No. 12 have had the whole of the free and albuminoid ammonia eliminated. . . . ."

There had therefore been perfect oxydation of the organic matter after passing the filter bed. This is further proved by the reduction in the oxydisable organic matter, as shown in column four of the analytical table "A."

For the information of your readers, I append *correct* tables of the International effluents, taken from the officially published reports of the Salford Corporation.

Trusting, in the interests of science, you will find space for these corrections.

TABLES OF THE INTERNATIONAL EFFLUENTS.

Dr. Burghardt.	Mr. Carter Bell.
Albuminoid ammonia in parts per 100,000.	
0·15	0·20	0·105
nil	0·14	0 18
nil	0·15	0·15
nil	0 05	0·04
0·07	0·16	0·24
0·15	0·06	0·18
0·15	0·06	0·05
...	0·12	0·02
...	0·14	0·02
...	0·12	0·07

Frank Candy, *Managing Director, The International Water and Sewage Purification Co.*

May 23rd, 1892.

Mercurial Poisoning.

In reply to Mr. Everard's letter on the above subject in your issue for May 20th, I would call his attention to the concluding paragraph of my article, from which he will see that I gave the whole credit to Monsieur Triquet. My object in writing the article was to draw attention to the antidote (which was an entire revelation to me a few months ago), in the hope that it might be used in other lamp factories and places where mercury is extensively employed, and where its evil effects are experienced.

I may add that Monsieur Triquet does not claim to have discovered the antidote from a medical point of view, but, so far as he is aware, he is the first to have used it in a systematic manner in industrial works.

With regard to the evil effects Mr. Everard speaks of as arising from the continued use of iodide of potassium, I find the men do occasionally complain of debility, and in such cases cease to take the salt for a period.

Legh S. Powell.

May 23rd, 1892.

The Kingdon Alternator.

Seeing in your issue of 20th inst. a reference to the Kingdon inductor alternator running "with varied success," and having had the only two Kingdon dynamos which are working at 2,000 volts in my charge ever since they were built, I may inform you that for more than twelve months they have been doing the work of the Woking Electric Supply Company, Limited, and during that time have needed no attention beyond once revarnishing the coils.

I have no interest whatever in puffing the Kingdon dynamos, but from the experience I have had, I think that though they may not be quite as efficient as some alternators are claimed to be, they are very well suited for central station work, especially where only a small staff can be maintained.

If you will kindly find room for this in your next issue I shall be much obliged.

Edward Mann.

May 21st, 1892.

CRYSTAL PALACE ELECTRICAL EXHIBITION. 1892.

Telephone Receivers.

The single-pole Bell receiver is being rapidly superseded by the double-pole instrument, in which both ends of the permanent magnet are utilised, as was done in the early form of Siemens's receiver.

The magnet is U-shaped, and is enclosed in the handle of the instrument. Two soft iron pieces are attached to the poles of the magnet, and form the cores for a pair of oblong coils. Some care is required to obtain parallelism between the cores of the electro-magnet and the diaphragm, and in some instruments we examined, the efficiency was reduced by the coils being spread wide apart from the centre of the diaphragm.

When properly constructed the double-pole receiver is unquestionably of greater efficiency than its predecessor, and many forms of the instrument are being placed before the public.

The watch form is becoming very popular, and for short distance, or domestic working, it is very convenient. A variety of patterns are exhibited at the different stalls, but

FIG 15.

the illustration, fig. 15, which shows the form manufactured by the Consolidated Company, may be taken as typical of the entire class.

This company exhibits a variety of patterns fitted with a specially designed ear piece, which fits comfortably upon the ear, and is very convenient to use.

The watch receiver possesses the merit of lightness, and is more convenient to handle than the ordinary form, but as a rule is less efficient than that with the long magnet.

The Western Electric Company manufacture a double-pole Bell receiver, which is probably the most efficient that has been produced. We understand that it is from 10 to 15 per cent. better than the single pole receiver. Fig. 16 is a

FIG. 16.

FIG. 17.

representation of the instrument, and at their stall quite a large array is displayed. They also construct a very efficient form of watch receiver, which is exceptionally light, the case being of aluminium.

The International Electric Company exhibit a modified form of Siemens's receiver made by Mix and Genest, Berlin, which is coming largely into use. It is shown at fig. 17. The electro-magnet is fixed sidewise upon the permanent magnet, instead of upon the ends. The permanent magnet forms the handle of the instrument, and is covered with leather. It is not so handy as the ordinary Bell's receiver, but gives a greater volume of sound, and for such places as factories, workshops, and noisy situations generally, it will no doubt be very useful.

The same firm exhibits an ingenious arrangement for preventing curious or inexperienced persons from removing the cap of a telephone receiver. A pin, S, fig. 18, penetrates

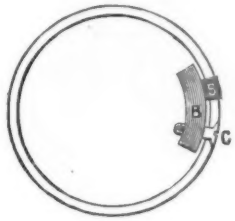


FIG. 18.

the threaded part of the metal case from the inside, where it is attached to a movable block, B. The clamping screw, C, passing through the metal case from the outside, enters B, as shown. When the cap of the receiver has been screwed up the clamping screw, C, is tightened, B and S advance, and S, across whose end the screw thread of the case is continued, presses upon the inner screwed surface of the cap, and holds it so securely that it is practically immovable, unless the screw, C, is released.

Table or Desk Telephones.

The extension of the telephonic service into dwelling houses, the private rooms of principals, managers of business houses, &c., has created a demand for an instrument more easily accessible to the user than the ordinary wall telephone. The table, or desk telephone, enables the means of communication by telephone to be brought to the elbow of the user, so to speak, and almost all the manufacturers of telephonic apparatus make some special pattern of table telephone, of which a variety suitable for all requirements is to be seen at the Exhibition.

Fig. 19 illustrates a circular pattern manufactured by the

FIG. 19.

Consolidated Telephone Company, and exhibited at work at their stall. The arrangement is neat and very compact. The circular box forming the base encloses the magneto-generator, which also serves as a dead weight to prevent the instrument being overturned upon the table. Supported by the pillar is a smaller box enclosing the magneto bell, bell switch, and

induction coil, and supporting externally two neatly embossed bell domes and the transmitter. The latter is granular, of a pattern known as the Fitzgerald, and specially manufactured by this company. A watch receiver completes the equipment. The circular boxes are covered with plush, which may be of any colour to harmonise with the surroundings, and the general appearance of the entire instrument is very pleasing.

Fig. 20 illustrates the pattern exhibited by the Western

Fig. 20.

Electric Company. As distinguished from that described above, a square base is provided made of ebonised wood, walnut or mahogany. The transmitter is of their granular form, and is mounted in such a way as to admit of being turned in any direction, independent of the position of the base upon the table when the apparatus has to be brought into use. It is also fitted with their latest form of switch lever, designed to afford greater security of contact between the lever and springs. A double-pole bell receiver is provided to complete the instrument, and forms, with the granular transmitter, a very powerful telephonic combination.

Fig. 21.

The latest instrument of this kind, produced by Messrs. Mix and Genest, is of very artistic design (fig. 21). It is arranged for calling by battery current, a press button and battery replacing the magneto-generator usually provided. The bell is concealed underneath the base, and the standard, which is cylindrical, encloses the induction coil. The microphone is fixed in a slightly slanting position, and is similar to that described last week (fig. 13). The combination is completed by a watch receiver suspended from the switch hook which projects from underneath the transmitter.

At the National Telephone Company's stall may be seen an elegant table telephone of the Ericsson-Bell type, manufactured in Sweden, and illustrating the class of apparatus used in that country. It is provided with a granular transmitter, very similar to that manufactured by the Western Electric Company, and a double-pole Bell receiver. The design and general appearance of the complete apparatus is excellent, and the workmanship is of a quality superior to that usually found in telephonic apparatus. The transmitter is mounted upon a revolving arm which describes a complete circle, and the stand containing the magneto-generator runs upon India-rubber rollers, which admit of the complete instrument being noiselessly moved about upon the table or desk. An Ericsson-Bell wall telephone is exhibited at the same stall, and in this instrument, also, the design and workmanship are alike equally excellent with the table instrument.

Telephone Exchange Switches.

Two descriptions of these are in general use, the one the ordinary switch in which each subscriber's line is terminated upon a switch spring or jack connected to one section of the switchboard, controlled by one particular operator, and directly accessible to that operator only; the other, the multiple switch, in which a connection from every subscriber's line is extended to every section of the switchboard, by means of which extensions each operator has access to every circuit coming into an exchange, independent of assistance from a colleague.

The most imposing exhibit of switch frames is that of the Western Electric Company, which occupies a pre-eminent position as manufacturers of this class of apparatus. Three types of switches are included in their exhibit; first, a switch known as the Scarborough; second, their Standard switchboard, and one section of Scribner's single cord multiple switch. In external appearance the two first-mentioned are very similar, but a radical difference exists in the methods of connection employed. Each board is fitted for 100 subscribers to be attended to by one operator. Where the work is at all brisk this number is generally found to be beyond the capacity of one attendant, and it is the more general practice to allot two switch clerks per 100 subscribers, 50 each being the number which experience has shown can be conveniently handled consistent with promptitude of attention and rapidity of connection. In the Scarborough board the connections are arranged so that when two lines are connected together the indicator of the subscriber called is cut out of circuit. This is effected primarily by employing a jack of special construction which is uniformly inserted into the called subscriber's line when a connection is made. The indicator of the calling subscriber is retained in the circuit for the purpose of registering the ring off signal, and is connected directly in the circuit, consequently it has to be spoken through. The deteriorating effect of an electro-magnet upon the speaking in a telephone circuit is well known, and with the expansion of trunk line systems, the time is within measurable distance when this method of connection will no longer be admissible, if the branch exchanges are to participate in the benefits of trunk line communication. That the company is fully alive to this requirement is amply demonstrated by their latest arrangement of Standard switchboard.

In the standard board which they exhibit the wiring is fully completed, and illustrates their general system, which is unique. The wires employed for connecting the indicators and the jacks have coverings of different colours. Each row is bound symmetrically together, and the ends led to the apparatus connected in such regular order that everything is well within sight, affording every facility for the detection and removal of faults.

Next week we shall conclude our articles on the telephones at the Crystal Palace with a detailed description of the switchboard made by the Western Electric Company.

(To be continued.)